Communal Land and Agricultural Productivity

COMMUNAL LAND AND AGRICULTURAL PRODUCTIVITY

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Abstract. This paper quantifies the aggregate impact of communal land tenure arrangements that prevail in Sub-Saharan Africa. Such tenure regimes limit land transferability by prohibiting sales, subjecting rented-out land to the risk of expropriation, and redistributing it to existing farmers in a progressive fashion. We use a general equilibrium two-sector selection model featuring agents heterogeneous in skills to compute the resulting occupational and operational choices as well as land allocations. The quantification of the model is based on policies deduced from Ethiopia. In the Sub-Saharan African context we find that such policies substantially dampen nominal agricultural relative to non-agricultural productivity, by 25%. Real relative agricultural productivity, however, only falls by 4% since cross-sectoral terms of trade adjust strongly, with excess agricultural employment only amounting to some 1.5 percentage points. The loss in GDP is small, about 2%. That serves as a reminder that ostensibly highly distortionary policies need not have substantial bite when individuals strategically adjust to them and equilibrium prices adapt. For example, the model predicts that at given prices 62% of farmers in an economy such as Ethiopia would leave farming if tenure were secured, casting land insecurity as a major obstacle. Yet only 9% would actually switch sectors after price adjustments are factored in.

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1. Introduction

One of the most salient and puzzling features distinguishing poor from rich economies is their low labor productivity in agriculture relative to non-agriculture. The cross-country gap in the relative agricultural productivity difference (APD) is large both in real as well as in nominal terms.[1] The *real* APD gap between the richest and poorest deciles of countries computed by Restuccia, Yang and Zhu (2008) and Caselli (2005) is estimated to be roughly a factor of ten. Our own calculations on more recent data, albeit employing an imperfect deflator, reveal a factor gap as high as twelve.[2] As for the more easily computable *nominal* APD gap, there is a factor of about 3.5 between the richest and poorest decile of countries. Even a series of adjustments (hours worked and human capital) as undertaken by Gollin, Lagakos and Waugh (2014b) will at the most halve these numbers.

Two questions come to mind. First, is the APD gap a phenomenon induced by policies in poor countries? Standard models hint at the likely properties of such policies: misallocation within the agricultural sector that lowers real productivity, incentives towards over-employment in farming that depress the agricultural price and thus lower nominal productivity. Second, do such policies have real welfare consequences or is the APD gap just a statistical red herring? Given that poor countries are populated mainly by farmers, a mechanical cross-sectoral reallocation of labor evokes low-hanging fruits in the quest to eradicate poverty around the world.[3] But that may well be a mirage brought about by distorted prices and selection.

This paper evaluates one policy institution, communal land tenure, that at face value has serious potential to contribute to the APD gap. Communal tenure regimes are prevalent in the developing world, and in particular in Sub-Saharan Africa where land ownership is usually either prescribed by customary law or the law does not recognize private ownership at all. The term "communal" is of course a catch-all for many characteristics that occur with distinct intensities in various places. The focus here is on a single specificity that is systematic in much of Sub-Saharan Africa, namely limited transferability of ownership and operational rights.[4] Whereas ownership bestows complete and exclusive individual operational user rights over land, the ultimate allocative control is typically vested in either the community or the state.[5] Operational rights are periodically and contingently reviewed. Crucially, expropriation and redistribution hinge on individual

[1] Value-added per worker in local prices (py) is referred to as nominal productivity. Price-adjusted value-added per worker (y) is referred to as real productivity. The real and nominal APD gaps are hence defined as $\frac{y_a^{rich}/y_n^{rich}}{y_a^{poor}/y_n^{poor}}$ and $\frac{p_a^{rich}y_a^{rich}/p_n^{rich}y_n^{rich}}{p_a^{poor}y_a^{poor}/p_n^{poor}y_n^{poor}}$, respectively.

[2] One stringent requirement for real sectoral comparisons is the availability of cross-country price data of agricultural producers *and* intermediate inputs. This limits the comparison to prices collected by the FAO around 1985. Our calculations on 2005 data ignore intermediate price differences, as shown in the Appendix. In any case, recent calculations of physical output per worker in the most relevant staple crop sectors by Gollin, Lagakos and Waugh (2014a) confirm a startlingly large real APD gap.

[3] See for instance Vollrath (2009) and McMillan and Rodrik (2011). This relates to the classical "dual-economy" conundrum studied in Lewis (1954) and Harris and Todaro (1970).

[4] According to Byamugisha (2013) only about 10% of rural land in Sub-Saharan Africa is registered. Registration is not an ideal metric for our purposes as unregistered land may not necessarily be difficult to transfer. On the other hand, registered land may just as well face serious obstacles to transferability, exemplified by Ethiopia and Tanzania. There, 42% and 11% of land, respectively, is under documented ownership (Bomuhangi, Doss and Meinzen-Dick (2011)), but land sales are legally impossible. We will use the reasonable figure of three-quarters of land as being communal, which coincides pretty much with the fraction of customary land in Uganda, a country representative of Sub-Saharan Africa in its variety of land regimes.

[5] There also exists collective ownership, though it is mainly limited to pastures. Our framework is ill-suited to analyze the additional classical incentive issues involved.

actions, and severe obstacles to market transfers may limit acquisition, lease or even inheritance. There is reason to believe that such policies negatively impact the relative agricultural productivity, and simple cross-country regressions do indeed indicate a statistically significant relationship between the APD (real as well as nominal) and tenure insecurity.[6]

The contribution of this paper is to quantify the distortions created by such policies via an equilibrium model. Our framework is an off-the-shelf selection model where agents of heterogenous skills make an occupational choice between agriculture and non-agriculture. Non-agricultural workers are employees while agricultural workers combine their labor with land operations to run individual farms. In addition to pure private land there exists communal land which is acquired in the form of individual grants of exclusive rights over one period. These rights are automatically renewed unless expropriation occurs. The key features of the communal regime are: (i) communal land sales are prohibited and the risk of expropriation rises in the fraction of the individual holding that is rented *out*; (ii) only current farmers are eligible to newly redistributed communal land, and the probability of receiving such a transfer is decreasing in the level of individual holdings. These modelling choices are partly grounded in evidence from our own structured and semi-structured data collection in Ethiopia and Uganda.

The model allows two types of misallocation. First, occupational distortions occur as individuals choose agricultural activities to shield current holdings from expropriation and to benefit opportunistically from additional transfers. Second, operational distortions are driven by individuals whose communal holdings exceed efficient operations but who are reluctant to rent them out due to the expropriation risk. Because communal land acts as a magnet into agriculture labor income ceases to be the only concern in the occupational choice. That lowers nominal agricultural productivity. Moreover, operational distortions as well as the influx of unskilled farmers act to depress real agricultural productivity. The key element of the model is that it is dynamic, for two reasons. First, any comparison across equilibria requires a stationary distribution that is independent of the initial allocation of communal land. Second, allowing individual skills to vary over time is at the heart of measuring the potential misalignment between individual productivities and the distribution of communal land.

For the quantification, a frictionless environment with no communal land serves to match cross-sectional sectoral income distributions for the U.S., as in Lagakos and Waugh (2013). In a second step we lower TFP and land endowment to match a representative Sub-Saharan economy before targeting a specific communal land regime. Our target choice is Ethiopia, a country where typical features of Sub-Saharan African customary tenure are institutionally formalized. There, the land distribution is highly egalitarian and tenants hold *de facto* permanent and inheritable user rights. All land, however, formally belongs to the state. Sales of land are illegal and rental arrangements are highly circumscribed. Many tenants have acquired official certificates of their user rights, but perceived land tenure remains insecure, with major land redistributions recurring up to 2000s.[7] In general, there is a sense that continued enjoyment of land rights is contingent on physical residence in the village.[8]

With policy parameters in hand we compare an economy with communal land to a frictionless one. Two environments are studied separately, a rich economy with few farmers as the U.S. and a poor economy with an agricultural employment level of Sub-Saharan

[6]See the Appendix for the regression results where we employ a cross-country index on tenure insecurity. That index, however, can not easily be used to draw conclusions on causality.

[7]See e.g. Deininger, Ali, Holden and Zevenbergen (2008) and Holden, Deininger and Ghebru (2009a).

[8]See e.g. Rahmato (2003).

Africa. When the fraction of communal land is raised to three-quarters, the real APD opens by some 24% in the rich economy, but only by roughly 4% in the poor one. As for the nominal APD, it opens by, respectively, 36% and 25%. These results indicate sizeable action on the nominal gap, but surprisingly little movement on the real one. They reflect a small increase in agricultural employment, up by 1 and 1.5 percentages points, respectively. As for GDP, it is practically not affected at all in the rich economy, and drops only by a modest 2% in the poor one. The conclusion is that communal land frictions may well manifest themselves in low nominal APD levels. Yet they are unlikely - at least in economies with many farmers - to account for much of the observed real APD gap, agricultural employment or aggregate output.

It turns out that allowing for forward-looking strategic behaviour and endogenous sorting largely undoes what *prima facie* appears to be a highly distortionary policy. Here, individual communal land holdings end up being sufficiently aligned with agricultural skills because talent changes slowly. It is the good farmers who, on average, end up detaining the land. True, many of the least-skilled agents are potentially eager to switch into farming where assets may be obtained for free, but a depressed price of agricultural goods shuts down the attractiveness of that sector. That equilibrium adjustment is a powerful force. The model suggests that in a country such as Ethiopia, at current prices, about 62% of farmers would switch into non-agricultural activities if the threat of expropriation were to be discontinued without pre-announcement. Taking account the ensuing price adjustments, however, only about 9% of farmers would actually switch sectors, trading place with about 12% of non-farmers moving in the opposite direction.

The sensitivity analysis reveals robustness to individual policy parameter variations. One illustrative parameter that does matter, however, is the elasticity of expropriation to the fraction of rented-out communal land. The benchmark parameter is such that the expropriation risk is almost nil for farming landlords. When the expropriation risk extends to farmers, the rental market for land shuts down, causing more serious operational missallocation, more agricultural employment, lower aggregate output, and a higher real, though not nominal, APD gap. Loosely speaking, the relative price of agricultural goods is a good indicator for real misallocation. When distortions only affect the occupational choice the attractiveness of farming is kept in check by a precipitous fall in the agricultural price that stems any overproduction of food. With the addition of operational distortions the oversupply of farmers raises agricultural output by little so that agricultural prices do not decline by much, leading to more severe misallocation.

This paper follows in the footsteps of a growing macroeconomic literature explaining the agricultural productivity gap through policies and sorting. An important contribution is Adamopoulos and Restuccia (2014b) who model heterogeneity in farmer skills to predict output losses associated with generic tax wedges. The results imply potentially large losses through misallocation. Restuccia and Santaeulàlia-Llopis (2015) uncover significant dispersion in farmer skills based on household data from Malawi. These data confirm the existence of potentially large operational wedges that may well be related to a lack of a functioning land market.[9] The model in the present paper is borrowed from Lagakos and Waugh (2013) in that individuals have distinct but correlated skills across the agricultural and non-agricultural sector.[10] Their message is that the real relative APD gap may arise

[9]At the aggregate level, Gollin, Parente and Rogerson (2004) explain the nominal APD gap by distortions that encourage home work in the rural sector, while Gollin and Rogerson (2014) attribute a fraction of it to high transportation costs. Restuccia et al. (2008) study the real APD gap through barriers to intermediate input use in agriculture.

[10]In a similar vein, the detailed cross-country empirical study by Young (2013) relates the APD gap in developing countries largely to selection across sectors.

naturally via differences in aggregate TFP that causes variations in average sorting across sectors - as sectors grow (decline) they attract (shed) increasingly unskilled individuals.[11] Ours is a complementary story that superimposes policy distortions on top of potential TFP differences.

Another closely related contribution is Chen (2014). He also investigates how non-transferable land holdings affect agricultural productivity in an environment with cross-sectoral heterogeneous skills. The paper differs from ours as it investigates an agricultural production function with more flexible properties that allows to target the farm size distribution. Our paper, meanwhile, is more general in the flexibility of the institutional environment that includes amongst others the possibility of renting out insecure land, albeit at a risk. We are also the first to investigate agricultural productivity through the lens of a dynamic environment featuring an endogenous distribution. Having agents take forward-looking decisions is not merely a token to realism, but rather spells out how distortionary policies lose bite due to strategic equilibrium adjustments. This sets us apart from another paper that is similar in spirit, Adamopoulos and Restuccia (2014a). They provide a precise case study of misallocation due to a sudden land reform and farm size caps in the Philippines. Their model allows for a quantification of a one-off event that is highly detailed. Their underlying institutional arrangement, however, is very distinct. We study a process of slow but continuous land redistribution where agents take actions to fend off the threat of expropriation, and where the ultimate distribution of communal land ownership evolves endogenously.

We also touch base with a sizeable microeconomic literature on tenure insecurity and agricultural productivity. A limited number of these papers focus on misallocation across users. The contributions in Holden, Otsuka and Place (2009b) for example provide indirect evidence that land sale and rental markets (which presumably depend positively on land security) produce allocative gains in several Sub-Saharan African countries. In the Ethiopian context de Brauw and Mueller (2012) find that perceptions of land tenure security foster increased rural-urban migration, though the effect is not particularly strong. A study on the Dominican Republic by Macours, de Janvry and Sadoulet (2010) finds that insecure land rights prompt owners to limit land rentals to close kin only, thus preventing allocation to more efficient users. In the case of Mexico, Macours, de Janvry and Sadoulet (2012) document that formal land titling enabled a market-based reallocation (through sales and rentals) to more productive land-poor from less productive land-rich farmers, and a stronger outmigration of the latter. These papers measure misallocation in a *partial* equilibrium setting while our paper stresses equilibrium adjustments.

One crucial aspect that the present paper ignores are productive investment incentives in the face of tenure insecurity. This is beyond the present paper, but we do note that our framework is well-suited for such an extension. Suffice it to say that the empirical literature on the effect of tenure insecurity on investment in the African context has been very active, identifying several pathways. First, investment can increase as the likelihood of recouping its returns is higher, as shown by Besley (1995) and Goldstein and Udry (2008) in studies on Ghana, by Ali, Dercon and Gautam (2011) in Ethiopia, and by Fenske (2011) in several countries in West Africa. Second, land investment may also decrease as individuals with weak titles feel more compelled to secure their user rights via intensive outlays - see for instance Sjaastad and Bromley (1997), Place and Otsuka (2002), and Deininger and Jin (2006). Third, securing land rights may raise collateral to

[11] Donovan (2014) also explains real agricultural productivity via differences in TFP in conjunction with incomplete financial markets. He exploits the notion that risky productive investment departs strongly from the first-best when farmers are close to subsistence consumption.

be used for credit and investment.[12] In Africa, however, such an effect has hardly been identified so far.[13]

The organization of the paper is as follows. The next section presents the model environment. Section 2 describes the model's equilibrium characteristics. In Section 3 we discuss the calibration strategy. Section 4 lays out the empirical results and tests the model's predictions under distinct parameter values. Section 5 concludes.

2. A Model of Communal Land

The economy is populated by a unit measure of infinitely lived individuals. These maximize present expected discounted utility with a period utility that is linear in expenditure b. Time is discrete and discounted at the factor $\beta \in (0,1)$. The individual's state space, denoted by x, includes the following elements: (i) his productive skill in the agricultural sector, $z_a > 0$; (ii) his productive skill in the non-agricultural sector, $z_n > 0$; and (iii) his endowment of communal land. Individual skills are exogenous and drawn from a joint cumulative distribution, $\{z_a, z_n\} \sim \Psi(z_a, z_n)$. With probability $\zeta \in [0,1]$ the individual's entire skill set is re-drawn in the following period, and otherwise persists unchanged. Communal land ownership l_c, on the other hand, evolves endogenously.

2.1. *Occupational choice and production*

In each time period the individual disposes of one unit of labor and opts for his current occupation, agriculture ($\mathbb{1}_a = 1$) or non-agriculture ($\mathbb{1}_a = 0$). In non-agriculture, there is a representative competitive firm that produces non-agricultural output Y_n according to $Y_n = AE$ where $E = \int [1 - \mathbb{1}_a(x)] z_n(x) \mathrm{d}H(x)$ denotes efficiency units in non-agriculture, and $A > 0$ is TFP. The non-agricultural wage in efficiency units is denoted by w while the price of the non-agricultural product is normalized to unity. With profit maximization an individual's non-agricultural labor income is hence $w_n(z_n) = wz_n$.

In agriculture, by contrast, each of our agents runs his own farm. Its output $y_a(z_a, l)$ depends on farming skills as well as the choice of land operations $l \geq 0$ according to

$$y_a = Az_a^{1-\gamma} l^\gamma.$$

The focus here is on land, which is why we abstract from variable labor inputs. Neglecting hired labor, at any rate, is not a major simplification as most farms as well as most of the farmland across the world (including in developed countries) is operated by family farmers. We also abstract from capital and other inputs to single out the interplay between skills and land operations.[14] Land is rented-in at the rate r, and agricultural output is valued at p so that agricultural labor income is simply $w_a(z_a, l) = py_a(z_a, l) - rl$. In the absence of frictions the agricultural production function yields a constant land share as well as linearity of labor income in skills.

Prior to the occupational choice the individual's budget constraint is

$$b = \mathbb{1}_a[pAz_a^{1-\gamma} l^\gamma - rl] + (1 - \mathbb{1}_a) wz_n + rL_p + rl_c.$$

Each individual owns an equal share of aggregate private land, L_p that earns a period return r.[15] Moreover, the individual may potentially earn income from renting out communal land holdings, l_c, to which we turn next.

[12]See Feder (1985) for a formal treatment. This idea has been popularized by De Soto (2000).

[13]Brasselle, Gaspart and Platteau (2002), for instance, reject it in a study on Burkina Faso.

[14]Admittedly, this functional form is simplistic and bound to fail in matching the farm size distribution. That probably requires a functional form that is far from homogeneous of degree one, as in Adamopoulos and Restuccia (2014b). While we have experimented with different functional forms and the inclusion of other production factors we ultimately prefer the present framework for the sake of clarity.

[15]This economy features no wealth effect so *private* land could just as well be unequally distributed.

2.2. *Communal land*

The economy's aggregate endowment of land is L. A fraction $\lambda \in [0,1]$ of it is communal, $L_c = \lambda L$, while the rest is strictly private, $L_p = (1-\lambda)L$. Communal land is held individually in the form of l_c, requiring $L_c = \int l_c(x)\mathrm{d}H(x)$. One central hypothesis is that within a given time period the individual has exclusive user rights over l_c, whether that be for the purpose of operation or out-rental. The sale of an individual's l_c, on the other hand, is not permitted. The frictions derive exclusively from the *dynamics* of individual communal land holdings that evolve through public interventions via expropriation and redistribution.

2.2.1. *Expropriation*

Expropriation is stochastic and occurs in the beginning of the following model period based on current period actions. When it occurs, it affects the entire current holding l_c. Individuals face no expropriation risk as long as they operate at least the equivalent of their entire holding, $l \geq l_c$.[16] When operations fall short of that level, $l < l_c$, the risk of expropriation is positive and increasing in the fraction of rented-out communal land, $(l - l_c)/l_c$. The principle of "use it or lose it" applies - by renting out land that is not entirely transferable, the individual increases the risk of losing it. Furthermore, we assume that the expropriation rate is highest in the case of zero operations, $l = 0$, which in our model coincides with the choice of non-agricultural employment.[17]

Formally, the expropriation hazard function is

$$m(l_c, l) = \begin{cases} \tau \left(\frac{l_c - l}{l_c}\right)^{\mu} & \text{if } l_c - l > 0; \\ 0 & \text{otherwise.} \end{cases}$$

The parameter $\tau \in [0,1]$ represents the highest possible rate of expropriation while $\mu \geq 1$ governs its curvature. The expropriation hazard is convex in both the absolute amount of rented-out land, $l_c - l > 0$, as well as its fraction, $(l_c - l)/l_c > 0$. The basic notion captured by that function is that presence, in the form of operations, matters. Consider two individuals who own distinct holdings l_c and $l'_c = \delta l_c$ such that $\delta < 1$, and who rent out an identical amount of land $\Delta = l_c - l = l'_c - l' > 0$. The potential loss suffered by the individual owning less land is larger since $m(l'_c, l')l'_c - m(l_c, l)l_c = \tau\Delta^{\mu} l^{1-\mu}(\delta^{1-\mu} - 1) \geq 0$. In this example, the larger landowner operates more land, signalling that its productive use is relatively high in his hands. The parameter μ spans all extreme cases. For $\mu \to \infty$ expropriation can only ever occur following non-agricultural employment, $l = 0$. For $\mu = 1$, meanwhile, each unit of rented-out land is subject to the same risk. Technically, $\mu > 1$ ensures that strictly positive land operations will be bounded away from the corner l_c.

The basic properties of these policies are informed by evidence from the micro development literature on tenure systems in Sub-Saharan Africa. We also build on evidence from our own data collection in Ethiopia and Uganda - please refer to the Appendix for more details. Table (9) documents that the majority of the interviewed household in Uganda (55%) believe that not moving away from the village is the best option to avoid expropriation.[18] In Ethiopia, surprisingly, the responses do not stress outmigration as

[16] We assume that agents operate their own holding l_c before renting in any additional land.

[17] We take a short-cut by assuming that non-operated land is invariably rented-out. Strictly speaking, expropriation is thought to increase in non-operated land so renting it out rather than leaving it idle is always a dominant strategy.

[18] Anecdotal evidence from unstructured interviews in Uganda suggests that migrating individuals typically do not lose their ownership of land under customary tenure. Rather, they make the use of that land available to (extended) family members. The opportunity cost is that no rent is paid. Also, should

a major contributing force towards expropriation. This contradicts the explicit policies that exist in all Regions of Ethiopia, as explained further below. However, the responses do suggest that the continuous use and good management of land matter as alleviating factors. Thus, 68% of the respondents emphasize that observable land investments are an effective device to lower expropriation risk (using modern agricultural techniques, growing trees, building irrigation canals). Also, a further 23% indicate that the avoidance of fallowing mitigates the expropriation hazard. These responses are in line with much of the literature on that topic, in particular Deininger and Jin (2006).

In our dataset, renting-out land is not cited as an important alleviating factor against expropriation. This is true despite formal or informal provisions that indicate otherwise. In Ethiopia, the law stipulates a cap on the fraction of land that can be rented out, while in Uganda customary land often cannot be rented out without communal consent. In addition, there is much evidence, including from our dataset, that rented-out land is beset by classical issues of moral hazard (nutrient depletion, squatting, missed payments) and adverse selection (low land quality). One group of individuals that is both particularly vulnerable to expropriation from tenants as well as dependent on out-rentals are the elderly (especially widows) who moreover typically own more land due to recent population growth - see for instance Bomuhangi et al. (2011). In addition, our assumptions are tightly linked to the absence of land sales markets. These can circumvent frictions in the rental market as long as financial markets work smoothly. In countries with public land such as Ethiopia and Tanzania land sales simply are not allowed, and may even represent a criminal offence. On customary tenure regimes such as much of Uganda, meanwhile, land sales are highly circumscribed as they require the joint consent of close family members as well as notables such as village chiefs or clan leaders.[19] Since in the above model a functional rental market acts as a perfect substitute for the sales market, expropriation due to non-operation can equally be interpreted as expropriation due to illegal land sales that occur for the purpose of bypassing a rental market with its natural frictions. Conversely, it can also be interpreted as the risk of expropriation by untrustworthy tenants who would not be rented-out to if sales were permitted.

2.2.2. *Redistribution*

If there is expropriation, there must be redistribution for the communal land market to "clear" - the second policy component. We assume that redistribution occurs stochastically in the subsequent time period via lump-sum transfers v. This is a suitable assumption because land reallocation in practice has a random component. One justification is that some individuals receive a better ex post treatment by the local authorities than others. We also postulate that only current farmers ($\mathbb{1}_a = 1$) are eligible for communal land transfers. Moreover, we entertain the assumption that redistribution is progressive in the sense that the probability of further transfers depends negatively on the amount of current communal holdings.

Formally, the redistribution function is defined as

$$g(l_c, \mathbb{1}_a) = \begin{cases} \phi \left[1 - \left(\frac{l_c/v}{1+l_c/v} \right)^{\epsilon} \right] & \text{if } \mathbb{1}_a = 1; \\ 0 & \text{otherwise.} \end{cases}$$

the owner return, the family typically receives a fraction of the land as a compensation for having kept it under protection.

[19] Based on our qualitative interviews, the circumstances in which land sales are tolerated by clan leaders and village chiefs are exclusively tied to situations of financial hardship (e.g. health shock, education expenditure, funeral ceremony) which means that land sales are only permitted for motives of insurance, and not for allocative purposes.

The parameter $\phi \in (0, 1]$ represents the highest possible probability of transfer receipt at zero current holdings ($l_c = 0$). The degree of progressivity of the transfer function, meanwhile, is governed by $\epsilon \geq 0$; the lower it is, the lower is the likelihood of an additional transfer for any given strictly positive level of $l_c > 0$. Conversely, as $\epsilon \to \infty$ the transfer policy becomes independent of current holdings. In the stationary equilibrium, lump-sum transfers are identical across periods. Equilibrium holdings of communal land can then be expressed on a discrete grid $l_c = nv$, where $n \in \mathbb{N}$ is the individual's history of the number of accumulated transfers uninterrupted by expropriation.

The policies governing the evolution of land ownership in Sub-Saharan Africa are often portrayed as an attempt to prevent the emergence of landless farmers, for instance by Udry (2011). In our own dataset - reported in Table (10) - most households in Ethiopia (41%) emphasize that communal land allocation occurs primarily to households with little land. Moreover, around a third of the respondents suggests that communal land allocation is completely random. In Ethiopia, only some 20% of respondents believe that communal land allocation follows a productive criterion (farmer output or farmer skill). In contrast, the respondents in Uganda do not stress the lack of land as being the major driver of land transfers. Rather, they argue that it is driven positively by farmer output or skill (47%). If land was indeed available primarily based on skill then the scope for misallocation is obviously limited. Our interpretation, however, is that these responses may not be surprising as an *equilibrium outcome*. The reason for this is that land transfers in the two countries have become very rare in recent years as population expansion exhausted the possibility to clear new land. Coupled with a relatively low realized expropriation and therefore redistribution rate, the responses are mostly hypothetical, and are likely to be biased by the observation that skilled farmers with high output coincide with those who detain rather much communal land. As will become obvious, our model generates that indeed skills and communal land holdings are positively correlated. But that relation occurs endogenously through sorting rather than via an explicit policy rule.

2.3. *Consumption*

Consumption occurs at the level of the aggregate economy by means of a stand-in household. Individuals contribute their expenditure levels b to the household's budget who then decides consumption levels by solving $\max_{C_a, C_n} U(C_a, C_n)$ subject to $pC_a + C_n = \int b(x)\mathrm{d}H(x)$. Utility is given by

$$U(C_a, C_n) = (C_a - \bar{C}_a)^{\eta} C_n^{1-\eta}$$

where η represents the relative preference for agricultural goods which are subject to a subsistence requirement $\bar{C}_a > 0$. The latter is the element that drives structural transformation in the present economy. The rationale for decoupling production from consumption decisions is that we do not want the curvature of the utility function to impact savings decisions through financial markets. In an alternative scenario we could presume that agents cannot perfectly insure against income shocks as in a standard Aiyagari-type economy. In that case the land rights regime would acquire a secondary purpose as an additional insurance vehicle to complete markets. While interesting in its own right, such an analysis is beyond the purpose of the present paper.

3. Stationary equilibrium

3.1. *Definition of the stationary equilibrium*

Starting from an initial distribution $H_0(x)$ such that $\int l_c(x)\mathrm{d}H_0(x) = L_c$, a stationary equilibrium is the set of individual decisions $b(x)$, $\mathbb{1}_a(x)$, $l(x)$, $y_a(x)$, $w_a(x)$, $\forall x$; implicit choices of $m(x)$, $g(x)$, and $l_c'(x)$, $\forall x$; aggregate prices p, r, and w; aggregate allocations C_a,

C_n, E, Y_n, and Y_a; the transfer value v; allocations $l_c(x)$, $\forall x$; and a stationary distribution $H(x)$, such that:
(i) all agents of type x solve their maximization problem;
(ii) the representative non-agricultural firm maximizes profits;
(iii) the aggregate household solves its maximization problem;
(iv) the agricultural market clears: $C_a = Y_a = \int y_a(x)\mathrm{d}H(x)$;
(v) the non-agricultural market clears: $C_n = Y_n$;
(vi) the non-agricultural labor market clears: $E = \int[1 - \mathbb{1}_a(x)]z_n(x)$;
(vii) the aggregate land market clears: $\int l(x)\mathrm{d}H(x) = L$;
(viii) expropriation equals redistribution: $\int l_c'(x)\mathrm{d}H(x) = \lambda L$;
(ix) the stationary distribution $H(x)$ is consistent:

3.2. *Aggregate outcomes*

Let us assume that the stationary equilibrium is well-defined, i.e. the economy is sufficiently productive to ensure $Y_a > \bar{C}_a$. The household's first order condition then pins down the agricultural price through $p = [\eta/(1-\eta)]Y_n/(Y_a - \bar{C}_a)$. Non-agricultural profit maximization results in $w = A$. The remaining equilibrium objects are p, r, and v, the endogenous distribution $H(z_a, z_n, l_c)$, as well as choices $\mathbb{1}_a(x)$ and $l(x)$.

3.3. *Characterization of individual choices*

Let V be the individual's value-function. It takes the following recursive form:

$$\begin{aligned} V(z_a, z_n, l_c) = \max_{\mathbb{1}_a, l} \Big\{ & \mathbb{1}_a w_a(z_a, l) + (1 - \mathbb{1}_a)Az_n + rl_c \\ & + \beta\Big(\mathbb{1}_a[1 - m(l_c, l)]g(l_c, 1)\mathbb{E}_{z'|z}\big[V(z_a', z_n', l_c + v)\big] \\ & + \mathbb{1}_a[1 - m(l_c, l)][1 - g(l_c, 1)]\mathbb{E}_{z'|z}\big[V(z_a', z_n', l_c)\big] \\ & + \mathbb{1}_a m(l_c, l)g(l_c, 1)\mathbb{E}_{z'|z}\big[V(z_a', z_n', v)\big] \\ & + \mathbb{1}_a m(l_c, l)[1 - g(l_c, 1)]\mathbb{E}_{z'|z}\big[V(z_a', z_n', 0)\big] \\ & + (1 - \mathbb{1}_a)(1 - \tau)\mathbb{E}_{z'|z}\big[V(z_a', z_n', l_c)\big] \\ & + (1 - \mathbb{1}_a)\tau\mathbb{E}_{z'|z}\big[V(z_a', z_n', 0)\big]\Big)\Big\} \end{aligned}$$

where $\mathbb{E}_{z'|z}[V(z_a', z_n', l_c)] = (1-\zeta)V(z_a, z_n, l_c) + \zeta \int V(z_a', z_n', l_c)\mathrm{d}\Psi(z_a', z_n')$.

We are now ready to identify the sources of misallocation, both occupational and operational. Notice that the mere existence of communal land ($\lambda > 0$) is not sufficient to create distortions. These can only arise through strategic actions when there is risk of expropriation or the possibility of transfer acquisition ($v > 0$) which is itself conditional on expropriation in equilibrium. Both of them require that $\tau > 0$. In the absence of expropriation, farmers would optimally choose land operations $\hat{l}(z_a) = (\gamma pA/r)^{1/(1-\gamma)}z_a$ with the corresponding labor income $\hat{w}_a(z_a) = [(1-\gamma)/\gamma](\gamma pA/r)^{1/(1-\gamma)}rz_a$. That is the optimal choice in the presence of expropriation as well, conditional on not detaining too much communal land, $\hat{l}(z_a) \geq l_c$. After all, mind that farmers choosing $l < l_c$ would both lower their labor income *and* raise the expropriation probability. Two thresholds are then of interest. The first is the point at which agricultural labor income with undistorted land operations equals non-agricultural labor income, $\hat{w}_a(z_a) = Az_n$, or $z_a = [r/(\gamma pA)]^{1/(1-\gamma)}/[(1-\gamma)r]\gamma Az_n \equiv B^\star(z_n; p, r)$. The second threshold is the one where optimal land operations exactly equal communal land holdings, $\hat{l}(z_a) = l_c$, or $z_a = [r/(\gamma pA)]^{1/(1-\gamma)}l_c \equiv B^\dagger(l_c; p, r)$.

3.3.1. *Occupational choice with undistorted land operations*

Let us first consider individuals such that $z_a \geq B^\dagger$, i.e. those who choose undistorted land operations conditional on agricultural employment. These are guys who rent-in as farmers - they detain little communal land relative to their farming skills. Such agents opt for agriculture if and only if

$$\begin{aligned} \hat{w}_a(z_a) + \beta\Big\{\tau\Big(\mathbb{E}_{z'|z}\big[V(z'_a, z'_n, l_c) - V(z'_a, z'_n, 0)\big]\Big) \\ + g(l_c, 1)\Big(\mathbb{E}_{z'|z}\big[V(z'_a, z'_n, l_c + v) - V(z'_a, z'_n, l_c)\big]\Big)\Big\} \geq Az_n. \end{aligned} \tag{1}$$

As long as $\hat{w}_a(z_a) \geq Az_n$, i.e. $z_a \geq B^\star$, agriculture is chosen independently of any strategic consideration. Thus, types $z_a \geq \max\{B^\star, B^\dagger\}$ *efficiently* opt for the agricultural occupation. Suppose now that $\hat{w}_a(z_a) < Az_n$, i.e. $z_a < B^\star$. From (1) we see that there are two forces that could convince such an individual to prefer the fresh air of the countryside to the glitz of the city. The first is the risk of expropriation. The higher is his communal holding l_c, the more he risks losing by choosing non-agriculture. The second is the promise of additional land transfers in future periods. The higher is the transfer probability $g(\cdot)$, the more appealing is the agricultural activity. It is worth mentioning that as long as $\mathbb{E}[V(\cdot)]$ is concave in l_c that second rationale declines in communal holdings, both because the next transfer become increasingly unlikely and because its added value diminishes. What we can retain is that there exists a threshold $\overline{B}(z_n, l_c; p, r, v)$ such that individuals $\max\{\overline{B}, B^\dagger\} \leq z_a < B^\star$ suboptimally choose agricultural employment. Compared to the undistorted equilibrium, they put downward pressure on the agricultural price p. They also exert upward pressure on the rental rate r by creating excessive demand $\hat{l}(z_a)$. They do not, however, feature distorted land operations.

3.3.2. *Occupational choice with distorted land operations*

On the other end of the spectrum, consider types $z_a < B^\dagger$, individuals characterized by large communal land holdings relative to their farming skills. As farmers, these individuals prefer to rent out land. Agriculture is chosen if and only if

$$\begin{aligned} w_a(z_a, l^\star) + \beta\Big\{[\tau - m(l_c, l^\star)]\Big(\mathbb{E}_{z'|z}\big[V(z'_a, z'_n, l_c) - V(z'_a, z'_n, 0)\big]\Big) \\ + g(l_c, 1)[1 - m(l_c, l^\star)]\Big(\mathbb{E}_{z'|z}\big[V(z'_a, z'_n, l_c + v) - V(z'_a, z'_n, l_c)\big]\Big) \\ + g(l_c, 1)m(l_c, l^\star)\Big(\mathbb{E}_{z'|z}\big[V(z'_a, z'_n, v) - V(z'_a, z'_n, 0)\big]\Big)\Big\} \geq Az_n \end{aligned} \tag{2}$$

where $w_a(z_a, l^\star) < \hat{w}_a(z_a)$ and $\hat{l}(z_a) < l^\star < l_c$.

These individuals can again be broken down into two types. There exist those for whom in principle $\hat{w}_a(z_a) \geq Az_n$, or alternatively $z_a \geq B^\star$. Observe from (2) that for any choice $\hat{l}(z_a) > 0$ they prefer the agricultural activity no matter what. Yet because $\hat{l}(z_a) < l_c$, they choose $l^\star > \hat{l}(z_a)$ and therefore $w_a(z_a, l^\star) < \hat{w}_a(z_a)$. To limit the probability of expropriation they decide for excessive land operations. Agents of type $B^\star \leq z_a < B^\dagger$ therefore optimally position themselves into agriculture, but distort land operations. Compared to the undistorted equilibrium they apply downward pressure on the agricultural price p through overproduction and upward pressure on the rental rate r via excessive demand, $l^\star - \hat{l}(z_a)$. Finally, we also have individuals of type $z_a < B^\star$. Absent the policy they would opt out of farming. Here, they may choose otherwise. Thus there exists a threshold $\overline{B}(z_n, l_c; p, r, v)$ such that types $\overline{B} \leq z_a < \min\{B^\star, B^\dagger\}$ inefficiently sort into agriculture *and* feature distorted land operations. They too exert downward pressure on p and raise r via excessive demand land on the rental market, $l^\star$.

In summary, the threshold of entering agriculture is always lower than in the first-best, $\overline{B} < B^{\star}$, and individuals such that $\overline{B} < z_a \leq B^{\star}$ are occupationally misallocated. Any additional operational distortions will depend on the difference between thresholds (1) and (2). That difference originates from the fact that renting out land while residing in the countryside raises the spectre of expropriation. When $\mu \to \infty$ we have that $m(l_c, l^{\star} | l^{\star} > 0) \to 0$, $l^{\star} \to \hat{l}(z_a)$, and (2) collapses to (1). In that case there exist no operational distortions, only occupational ones.

3.4. *General equilibrium forces*

Compared to the first-best, the direct consequence of the distortions is a push towards a lower agricultural price p and higher rental rate r. In equilibrium, this discourages some potential farmers from entering agriculture. These are typically those with little communal land and a relatively high outside option in non-agriculture. When agricultural and non-agricultural skills are strongly correlated, such agents may well be highly skilled potential farmers. It is therefore not obvious whether in equilibrium we end up with relatively high or low agricultural output, i.e. whether the price of the agricultural good is likely to be lower or higher than in the first-best. We loosely juxtapose two potential scenarios to describe the general equilibrium difference between the communal regime and the first-best.

In the first scenario the additional individuals drawn into agriculture in the communal regime are relatively good farmers. Operational distortions are low, either because communal land is held predominantly by relatively good farmers or because the rental market of communal land remains sufficiently active. The economy pushes towards excess production of agricultural output so that its price p drops steeply. This limits the number of potential farmers and the aggregate effect on occupation is limited. The other scenario is one where the influx of farmers creates large distortions in land operations. Agricultural production therefore does not rise much in relatively terms, and may even fall. As a result, the agricultural price p does not drop strongly or and may even increase. Lacking a strong countervailing general equilibrium force, the economy exhibits a large mass of farmers vis-à-vis the first-best.

4. Calibration

We propose the following calibration strategy. As a first step, we determine the parameters governing the skill distribution, technology and intratemporal preferences by matching empirical outcomes from the U.S., an environment featuring no communal land ($\lambda = 0$). Targeting an environment that is relatively frictionless as opposed to, say, economies in Sub-Saharan Africa, allows to net out other prevalent sources of distortions and market failures, such as financial, product or labor market frictions. In the second step of the calibration, we introduce communal land policies. Since the space of potential policies is large, we calibrate our policy parameters to match features from the land holdings distribution in Ethiopia.

4.1. *Skill distribution, technology, and preferences over goods*

The level of TFP (A) and the total endowment of land (L) are normalized to unity. For the distribution of sectoral skills we follow Lagakos and Waugh (2013) by assuming that $\Psi(z_a, z_n) = C[\Psi_a(z_a), \Psi_a(z_a)]$ is a Frank copula of the individual Fréchet distributions $\Psi_a(z_a) = \exp(-z_a^{-\psi_a})$ and $\Psi_n(z_n) = \exp(-z_n^{-\psi_n})$. The parameter $\rho \in (-\infty, \infty)\backslash\{0\}$ governs the interdependence of the draws, with possibilities ranging from complete negative interdependence ($-\infty$) via independence (0) to complete positive interdependence (∞). Because our benchmark model almost exactly matches that of Lagakos and Waugh (2013) we can run with their calibrated parameters ($\psi_a = 5.3$, $\psi_n = 2.7$, and $\rho = 3.5$) to hit the proposed equilibrium outcomes. These are the cross-sectional variance in the persistent component of agricultural and non-agricultural labor income in logs (0.144 and 0.224, respectively) as well as the aggregate ratio of average agricultural to non-agricultural labor income (0.701).[20]

The parameter γ is set to 1/3, translating into an aggregate land income share of one-third in the agricultural sector. This is somewhat higher than the value found in Valentinyi and Herrendorf (2008) where income accruing to land is a fraction $0.18/(0.18+0.64) = 0.28$ of the combined labor and land shares. Such a relatively low land share results from the imputation of the indirect contribution of land from non-agricultural intermediate inputs for which land is negligible. Since we define output as value-added, that approach is in principle correct. However, labor income here is defined at the industry level so we prefer to limit the decomposition of land and labour shares to the industry. Historically, share-cropping arrangements have assigned by rule-of-thumb a value of between 1/3 and 1/2 to landowners as reported e.g. in Mundlak (2005) so we settle for the more conservative lower bound.

The preference parameter η is fixed at 0.01. We then set the subsistence requirement $\overline{C}_a$ to 0.03 to match an agricultural employment rate of 2 percent. The resulting outcome suggests that subsistence represents 27 percent of U.S. agricultural consumption. This is reasonable to the extent that the lowest average energy intake in countries such as Eritrea or Congo is about 42 percent of the U.S. value.[21]

4.2. *Policy and intertemporal parameters*

To compute the benchmark policy parameters we first modify the endowments so as to generate an environment reminiscent of Sub-Saharan Africa. We lower the land endowment to $L' = 1/3$ as this corresponds exactly to the endowment of arable land per capita of Ethiopia relative to the U.S. It also matches pretty well the endowment of arable land per capita of the World Bank's Least Developed economies relative to the U.S., which stands at 0.37.[22] Second, we lower aggregate TFP to $A' = 1/19$. In the absence of communal land this generates an agricultural employment share of 0.642 and GDP per capita of 0.037 relative to the benchmark economy.[23] Empirically, the agricultural employment share in Sub-Saharan Africa corresponds to 0.568 while GDP per capita is 0.045 relative to the U.S.[24] The choice of TFP cannot hit both targets simultaneously so we content ourselves with a convex combination of the two.

In the absence of communal land the calibration is independent of any intertemporal choices. To match policies, let the time unit be a year. We first fix $\beta = 0.96$, a standard time discount factor used in frictionless environments to generate an interest rate of 4 percent. Second, we set the hazard rate ζ to 0.025, which implies that the entire set of individual-specific skills changes on average once in 40 years, or roughly once in a generation. Such a choice is halfway between recognizing the respective likelihood that the

[20] The frictionless version of our model is identical to that of the extended version of Lagakos and Waugh (2013) in Section 5 in absence of capital.

[21] Statistics available from FAO at www.fao.org.

[22] See http://data.worldbank.org/indicator/AG.LND.ARBL.ZS.

[23] We compare GDP across economies using the agricultural price p^B generated for the baseline U.S. economy, i.e. $(p^B Y_a + Y_n)/(p^B Y_a^B + Y_n^B)$. As is well known, international GDP comparisons are based on international prices that give disproportionate weight to rich economies, in particular the U.S.

[24] Due to missing data we compute the average agricultural employment share as an average over the period 2003-2012, which captures most of Sub-Saharan African countries. GDP per capita is taken from http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD.

within-generational autocorrelation is not perfectly positive while the cross-generational one is, albeit more weakly.

Table 1. Calibration

Parameter	Value	Target	Data
No communal land ($\lambda = 0$)			
Land endowment (L)	1	Normalization	-
TFP (A)	1	Normalization	-
Land factor intensity (γ)	1/3	Land share in production	-
Fréchet agriculture (ψ_a)	5.3	Variance log agr. income	0.144
Fréchet non-agriculture (ψ_n)	2.7	Variance log non-agr. income	0.224
Interdependence (ρ)	3.5	Labor income agr. vs. non-agr.	0.701
Subsistence ($\overline{C}_a$)	0.03	U.S. agr. empl. share	0.02
Preference agr. (η)	0.01	Avg. energy intake poorest vs. U.S.	0.42
No private land ($\lambda = 1$)			
Land endowment (L')	1/3	Farmland/person poorest vs. U.S.	-
TFP (A')	1/19	Africa agr. empl share & GDP	-
Discount factor (β)	0.96	Frictionless interest rate	0.04
Hazard skill change (ζ)	0.025	Exp. duration of skill set (years)	40
Max. expropriation probability (τ)	0.5	Max. rented fraction of land	-
Max. transfer probability (ϕ)	0.211	Fraction of landless households	0.034
Progressivity of redistribution (ϵ)	0.024	Expropriation rate	0.005
Curvature of expropriation (μ)	5.341	Share of rented land	0.177

The policy parameter with the clearest interpretation is τ, i.e. the maximum expropriation hazard conditional on choosing non-agricultural employment. We parametrize τ to 0.5 based on the *Federal (2005)* and *Regional (2007) Land Proclamations* of Ethiopia. Not only do these declarations assert the criminal nature of land sales, they also set the rules for leases between peasant farmers. The Federal Proclamation allows such leases, but only without causing displacement, i.e. migration. The Regional Proclamations, meanwhile, set limits on the amount and duration of land that can be rented out. This varies between three (Oromia, Tigray) to five (Amhara) years, and between 50% (Oromia, Tigray) to 100% of land holdings (Amhara). Based on these rules we posit that the entire land holding can be rented out following permanent migration, but that expropriation kicks in on average after two years.[25]

We now turn to the calibration of our policy parameters to Ethiopia by using the LSMS-ISA dataset of 2011 as well as our own dataset of 2014. In Ethiopia private property of land is not recognized so we set $\lambda = 1$ with a light conscience.[26] The policy parameters ϵ, μ, and ϕ are calibrated jointly by matching features of the distribution of land operations. Two moments of interest are the fraction of rented-in land and the fraction of landless households. Based on the LSMS-ISA database, the fraction of rented-in land, namely the ratio of the total surface of rented land in the sample relative to the total surface of surveyed land, amounts to 17.7%.[27] The fraction of landless households, amounting to 3.4%, corresponds to the share of households whose entire operations are rented-in. The third moment, the equilibrium rate of expropriation, is computed based on our own dataset. We determine a lower and an upper bound for the expropriation rate based on interview questions that we then adjust to the periodicity of the model. The space that

[25]This strikes a balance between the facts that in reality, expropriation may arrive later while not all land can be rented out.

[26]"Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange," according to Article 40 of the *Constitution of Ethiopia*.

[27]Descriptive statistics of these variables are to be found in Table (6) in the Appendix.

we obtain for the expropriation rate ranges from 0.25% to 0.85%. Based on this evidence, we fix the expropriation to 0.6% and later conduct sensitivity analyses.[28]

The resulting parameters merit comment. The probability of obtaining a land transfer, $\phi = 0.211$, implies that farmers remain on average landless for roughly 5 years. The curvature parameter of the redistribution function, $\epsilon = 0.024$, is very low. It implies that the transfer probability drops steeply after the first transfer, which is consistent with the highly egalitarian land distribution in Ethiopia. Finally, the curvature parameter of the expropriation probability, $\mu = 5.341$, is very high. It implies that short of renting out all communal land, there is very little risk of expropriation. Again, this is reasonable as the rental market in Ethiopia is quite vibrant. Table (1) summarizes the calibration.

5. Quantitative results

In the following we employ the quantitative version of the model to gauge the effect of introducing communal land into a frictionless economy. We investigate several fractions of aggregate communal land while keeping constant all the other policy parameters backed out in the section above. The experiment is run separately in two distinct environments, the benchmark U.S. economy as well as the baseline poor economy reminiscent of Sub-Saharan Africa.

5.1. *Benchmark economy*

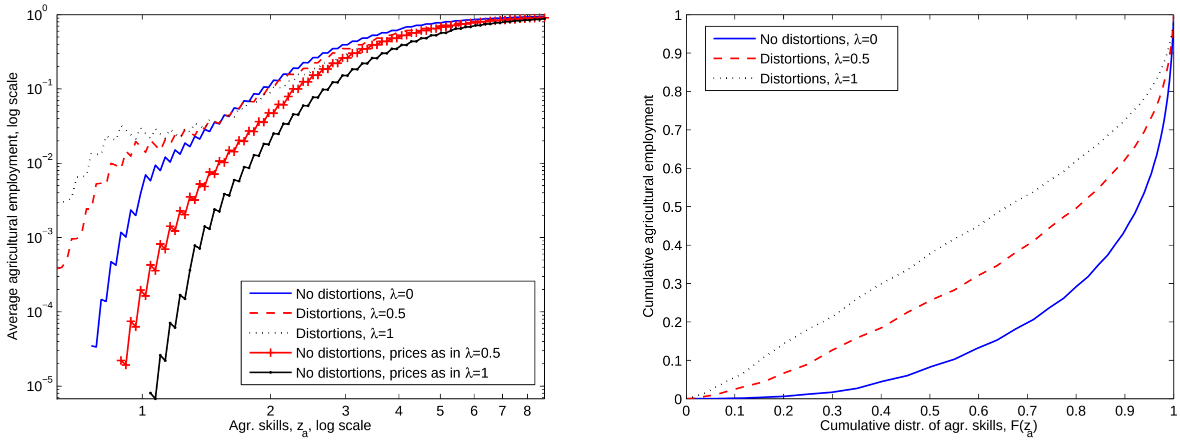
How does the rich world fare in the presence of communal land? While being admittedly a rare phenomenon in very rich countries, this thought experiment extends to any country with relatively few farmers. It certainly includes a number of Asian and even Latin American economies where communal land arrangements exist in various forms and guises.

5.1.1. *Individual choices*

We first focus on the impact that communal land generates on individual choices. Figure (1) depicts average agricultural employment as a function of agricultural skills z_a, integrated over types z_n and l_c. From the left panel we note that compared to the efficient equilibrium (solid line), the presence of distortions (dashed line for $\lambda = 0.5$, dotted line for $\lambda = 1$) induces a larger fraction of low-skilled farmers to work in agriculture. Inversely, skilled farmers are less likely to be employed in agriculture since its price p plummets, rendering that activity less lucrative. The decomposition into direct distortions and general equilibrium forces is visible by observing the (partial equilibrium) policy choices in absence of misallocation (setting $\tau = 0$ as well as $\upsilon = 0$) computed at the respective price levels p and r of the two distorted equilibria of interest. For instance, the prices prevailing at $\lambda = 1$ translate into significantly fewer farmers in the absence of distortions. The difference between that choice and the actual outcome measures the appeal of agricultural employment directly resulting from the communal land policy. To get a sense of the magnitude of the occupational misallocation, the right panel of Figure (1) presents cumulative agricultural employment as a function of cumulative farmer skills. Clearly, the presence of communal land can substantially water down the pronounced sorting of good farmers into agriculture that results in the first-best.

We now turn to land operations, conditional on agricultural employment, as depicted in the left panel of Figure (2). The presence of communal land features a mass of farmers operating land who do not exist in the absence of that policy regime. Over some range we can now observe negative assortative matching between farming skills and operations - out of the very unskilled farmers only those with sufficient endowments of communal

[28]See Table (7) in the Appendix.

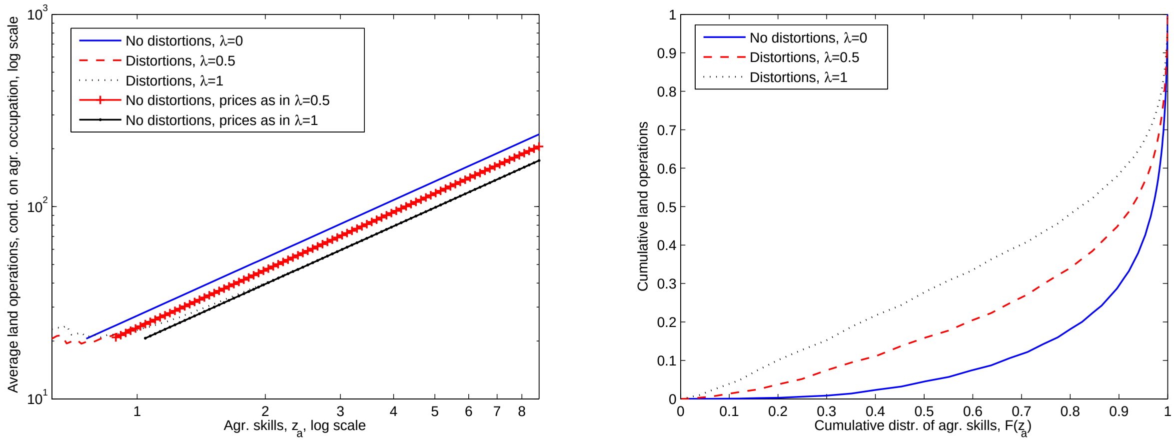


(A) Average agr. employment

(B) Cumulative agr. employment

Figure 1

land are willing to operate farms, and their land use is excessive. For the more skilled farmers, operations are on average not significantly impacted by the policy regime *per se*. They do, however, operate less land than their peers in the undistorted economy because of equilibrium price differences. This is an indication that - conditional on agricultural employment - land operations are by and large not subject to strong misallocation other than through general equilibrium forces. In effect, because renting out communal land bears little expropriation risk conditional on farming, a fair number of agents become rural-based renting-out landlords. Consequently, the distortion arising from the pure operational choice plays second fiddle to that of the occupational one. The total amount of misallocation, of course, stems from both occupational and operational choices, which can be observed in the right panel of Figure (2). The communal land regime dampens the positive relationship between land operations and farming skills.

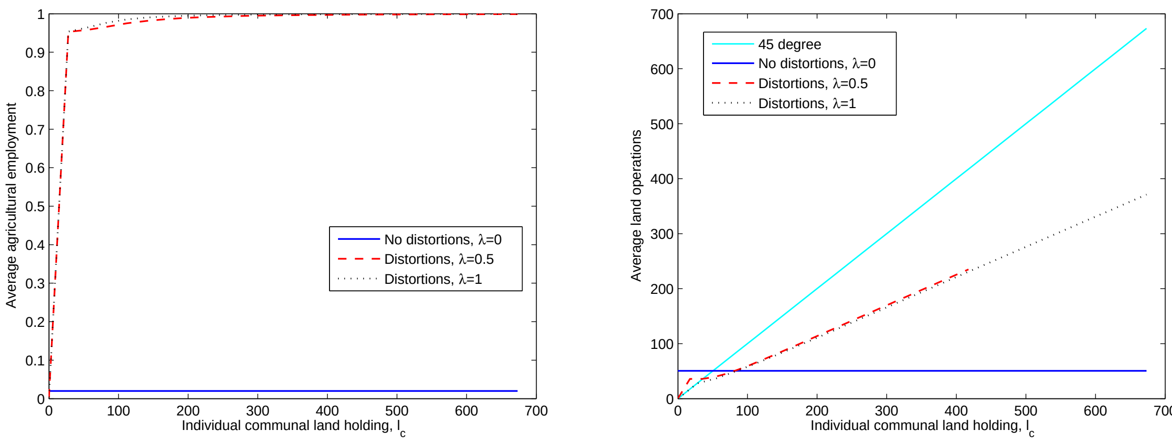


(A) Average land operations

(B) Cumulative land operations

Figure 2

Next, consider individual actions as a function of their communal land holdings, portrayed in Figure (3). In the baseline equilibrium actions are evidently independent of holdings.[29] In each of the distorted equilibria, on the other hand, landless individuals are less likely to operate land (right panel), since they shun agricultural employment (left panel). Two equilibrium forces are at play. The first is the fact that relative to the baseline world individuals owning little communal land see few incentives to become farmers. True, agriculture does open the possibility of obtaining future transfers, but the depressed price for agricultural produce dominates the choice. The other equilibrium force is that those individuals who do own communal land are more likely to be better farmers in the first place. Because the skill set changes slowly, about once in a generation, the stock of communal land holders is disproportionately drawn from previously and hence persistently talented farmers. The lucky agents detaining any positive amount of communal land will hence almost surely opt for the agricultural occupation (left panel). They will not, however, operate all of their holdings due to the aforementioned low expropriation rate conditional on farming. This can be viewed from the departure of operations from the 45 degree line. In addition, we note that the distribution of communal land (not shown) is highly skewed to the left for both $\lambda = 0.5$ and $\lambda = 1$, so there is a trivial mass of agents that are truly rich in communal land.



(A) Average agr. employment

(B) Average land operations

FIGURE 3

Finally, what would happen if an unannounced policy change terminated both the threat of expropriation as well as land transfers? The economy would jump instantaneously to the undistorted equilibrium. Two scenarios are of interest, summarized in Table (2). First, the mass of farmers motivated to change their occupational and/or operational choices if they did not take into account the resulting price variations. In other words, given existing prices, how constrained do farmers feel in their choices because of the land regime? For $\lambda = 1$ ($\lambda = 0.5$), we have that only 8.5% (24.5%) of the farmers feel unconstrained. Some 0.6% (0.3%) would stay in farming but lower their land operations, 38.3% (68.6%) would leave farming despite not facing operational constraints, and 52.6% (6.6%) would leave farming as they also face operational constraints. In absence of equilibrium forces, the communal land regime therefore suggests a large number of individuals who are in agriculture only due to existing policies. When all land is communal, there is also a large mass that would prefer to rent out more land. What matters, though, is how many individuals would actually switch occupations taking stock of the simultaneous

[29]Here, these holdings are naught, but remember this would also be true in the absence of expropriation ($\tau = 0$).

price adjustments. We find that for $\lambda = 1$ ($\lambda = 0.5$), 46.1% (29.8%) of farmers would be still be willing to switch into non-agriculture. There is not much movement in the opposite direction as only about 0.2% (0.1%) of current non-agricultural workers would prefer to switch into farming.[30]

TABLE 2. Fraction of constrained individuals

	$\lambda = 0.5$ Partial eq.	$\lambda = 0.5$ General eq.	$\lambda = 1$ Partial eq.	$\lambda = 1$ General eq.
Rich economy ($A = 1$, $L = 1$)				
Farmer, unconstrained, stay (%)	24.5	67.5	8.5	39.0
Farmer, constrained, stay (%)	0.3	2.6	0.6	15.0
Farmer, unconstrained, switch (%)	68.6	25.5	38.3	7.9
Farmer, constrained, switch (%)	6.6	4.3	52.6	38.2
Non-farmer, switch (%)	0.0	0.1	0.0	0.2
Non-farmer, stay (%)	100.0	99.9	100.0	99.8
Poor economy ($A' = 1/19$, $L' = 1/3$)				
Farmer, unconstrained, stay (%)	62.3	88.6	26.4	60.6
Farmer, constrained, stay (%)	3.7	5.7	11.3	30.5
Farmer, unconstrained, switch (%)	30.1	3.8	35.2	0.9
Farmer, constrained, switch (%)	3.9	1.9	27.1	8.0
Non-farmer, switch (%)	0.0	8.4	0.0	12.1
Non-farmer, stay (%)	100.0	91.6	100.0	87.9

5.1.2. *Aggregate statistics*

The next plots illustrate a number of key aggregate observations. We pay particular attention to the comparison between the frictionless environment and the one in the range of $\lambda \in [0.5, 1]$, i.e. economies where communal land predominates. Figure (4) depicts the evolution of real statistics over the institutional space. Aggregate agricultural output (Y_a) rises substantially with λ, by up to 17%, while non-agricultural output (Y_n) falls minimally, by no more than half a percent. Overall, GDP measured in benchmark economy prices drops trivially.[31] The key variable underlying these changes is agricultural employment (last panel). For $\lambda = 0.75$ it reaches about 3% compared to the benchmark of 2%. Is that a lot? It is certainly not a big change in absolute terms, which is why we can hardly expect large changes in GDP or in non-agricultural production. In relative terms, however, a sectoral employment increase of 50% is not trivial. Comparing production and employment, real agricultural productivity, Y_a/N_a falls enormously. Real non-agricultural productivity, Y_n/N_n, rises trivially as the aggregate effects are too modest to have substantial bite into either the numerator or the denominator.

We turn to relative productivity and prices, Figure (5). Following the previous discussion, real relative productivity in agriculture, $(Y_a/N_a)/(Y_n/N_n)$, must fall (first panel). At $\lambda = 0.75$, our central focus, there is a substantial drop of about 25%. The statistic that experiences even more action is nominal relative agricultural productivity, $(pY_a/N_a)/(Y_n/N_n)$. At $\lambda = 0.75$ we end up with a plummet of more than 35%. This is because of the decline in the relative price of agricultural goods p. We interpret this to be a consequence of the relatively few distortions that occur on the land market. Compared to the baseline prices, the presence of communal land makes agriculture attractive for many would-be farmers.

[30] In terms of masses the difference is of course much smaller as agriculture employs significantly fewer individuals in the distorted equilibrium, as discussed shortly. Still, the flow from agriculture into non-agriculture is an order of magnitude larger than the flow in the opposite direction.

[31] GDP drops because the base level of Y_n is much higher than that of Y_a, while the original relative price is $p = 0.27$. The quantitative evolution of welfare, measured via the stand-in household's utility function, is almost identical to that of GDP. We do not report welfare here, but note that it is highly aligned with the GDP measure in all of the subsequent experiments as well.

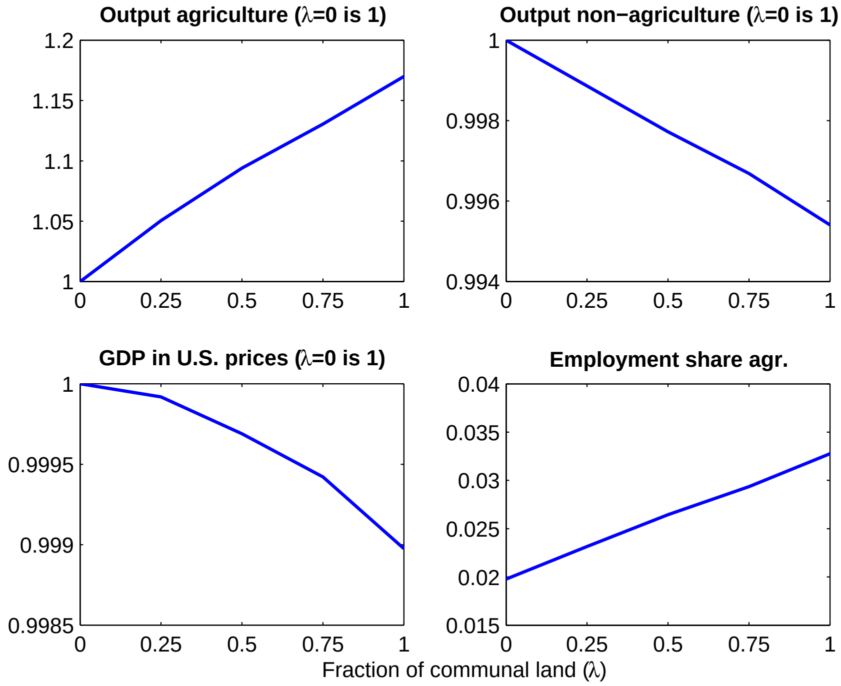


FIGURE 4. Real variables

The new entrants as well as the resulting land allocations do not wreak havoc on farming, but rather contribute to agricultural output gains. As a result the agricultural price must decline, which limits the number of entrants. The loss in real relative agricultural productivity is therefore subdued while the nominal one is pronounced. As for the rental rate of land (last panel), it is lower under communal land arrangements. That also results from the drop in the agricultural price. Despite the aforementioned upward pressure induced by the limited supply on the rental land market, the decline of the agricultural price puts a lid on demand for land. In addition, the fact that the rental market remains sufficiently active (even with no private land) implies that the supply of rented land is not extremely curtailed.

Additional policy-induced variables of interest are summarized in Figure (6). The first panel plots the transfer size with respect to the mean farm size. It is almost exactly linear in λ, for two reasons. First, the vast majority of communal land holders detain one single transfer, $l_c = v$. Second, almost all of the communal land is owned by farmers. It follows that in the extreme case of no private land, land ownership - though not the operation of land - is extremely equally distributed. Mind that the expropriation rate (second panel) is quite high at more than 2% and it does not vary much across different (strictly positive) fractions of aggregate communal land. The share of farmers with no communal land also does not change much over different fractions of aggregate communal land (third panel). Finally, we note that the fraction of communal land that is rented out (fourth panel) increases with λ - as less private land is available there is increasing pressure to rent out communal holdings.

5.2. *Poor economy*

We repeat the above exercise in an environment that is representative of Sub-Saharan Africa in output, agricultural employment, and land endowment. It is obviously the more interesting counterfactual experiment - communal land is after all mostly found in rural

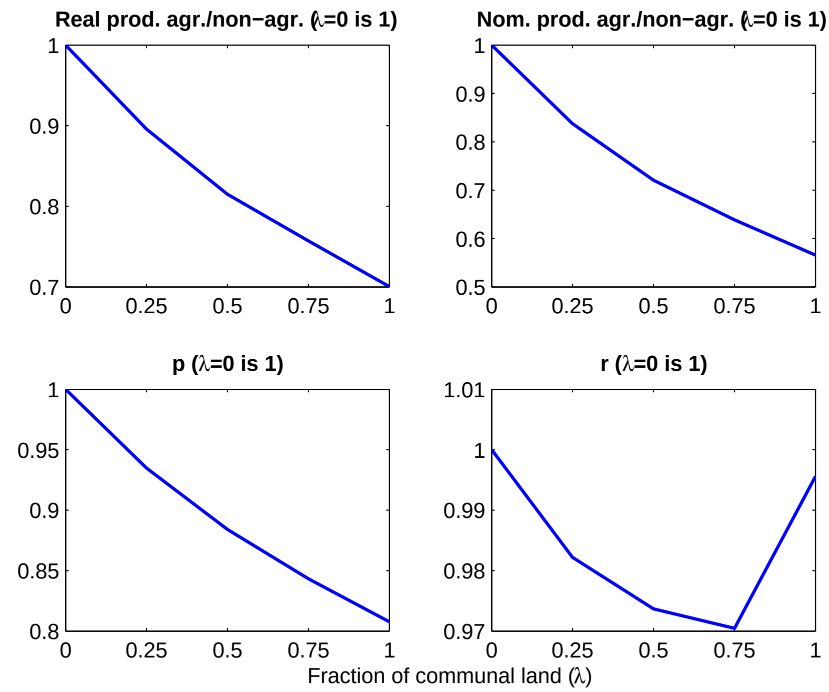


FIGURE 5. Relative productivity and prices

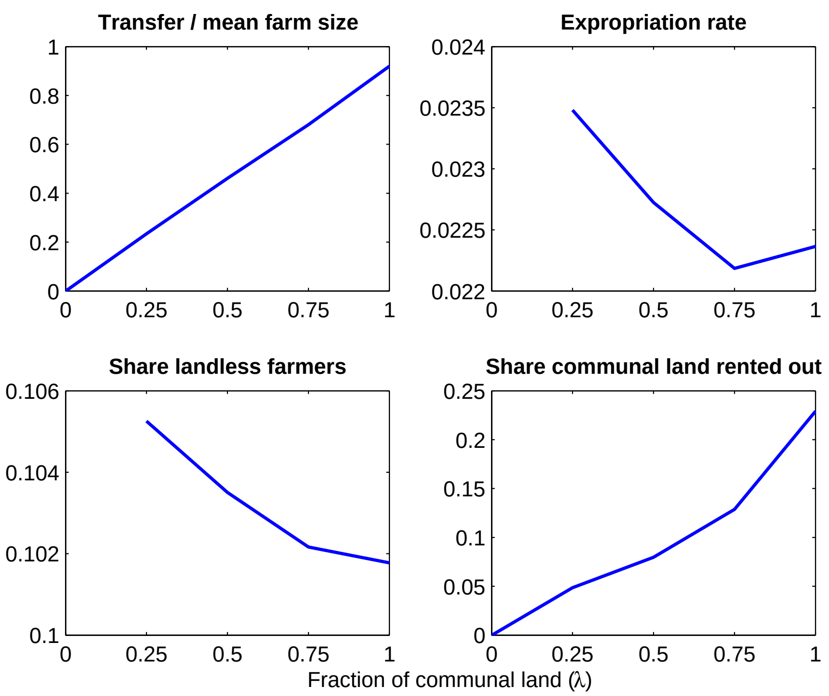
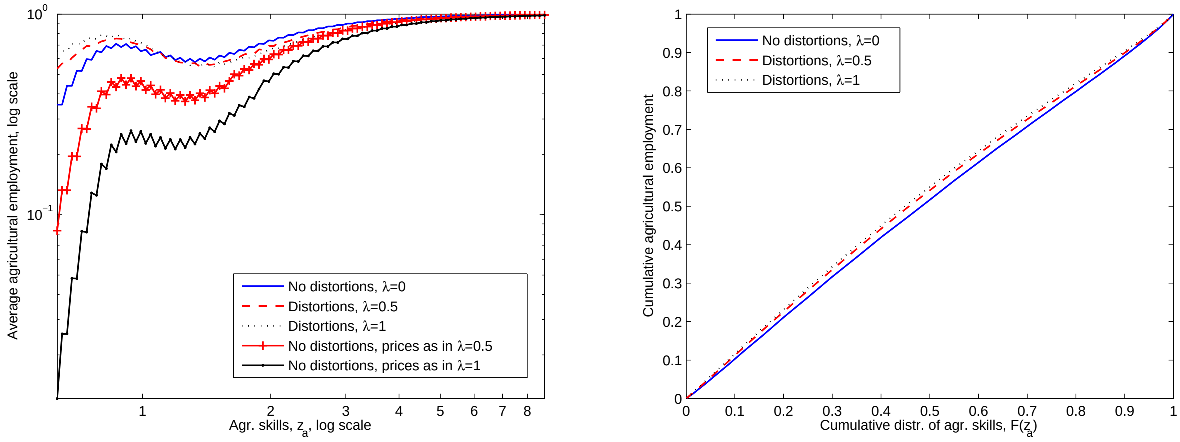


FIGURE 6. Variables on communal land

economies. We recognize, however, that we are on somewhat shakier ground here as the cross-sectional variations in income in the baseline are not directly targeted to such economies.

5.2.1. *Individual choices*

From the left panel of Figure (7) we observe that even in the frictionless economy positive assortative matching between agricultural employment and agricultural skills breaks down over a portion of the skill state space. This is a by-product of the positive correlation across sectoral skills, as better farmers also tend to be better non-farmers. The communal land regime accentuates that pattern. Because negative assortative matching occurs on a segment with substantial mass, in the distorted equilibrium agricultural employment ends up being negatively correlated with agricultural skills. One can appreciate that from the right panel where the plot for the distorted economy lies above the 45 degree line.



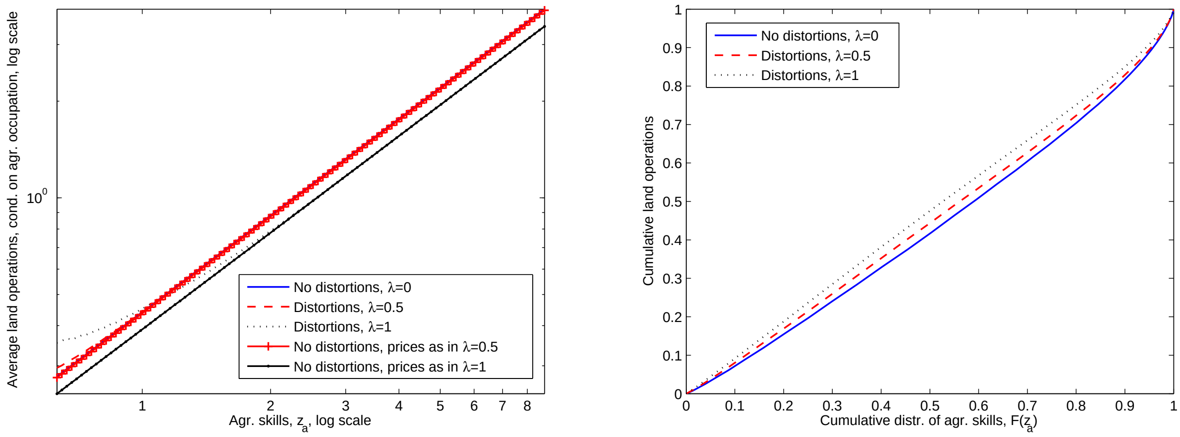
(A) Average agr. employment (B) Cumulative agr. employment

FIGURE 7

The left panel of Figure (8) illustrates land operations, conditional on farming. We note that the economy requires a large fraction of communal land to manifest distortions in conditional land operations. Taking stock of occupational and operational choices (right panel), the communal land regime dissipates the unconditional positive relationship between operations and farming skills that exists in the first-best. That association, however, is weak to begin with, which implies that there is little room for large operational misallocation in any case.

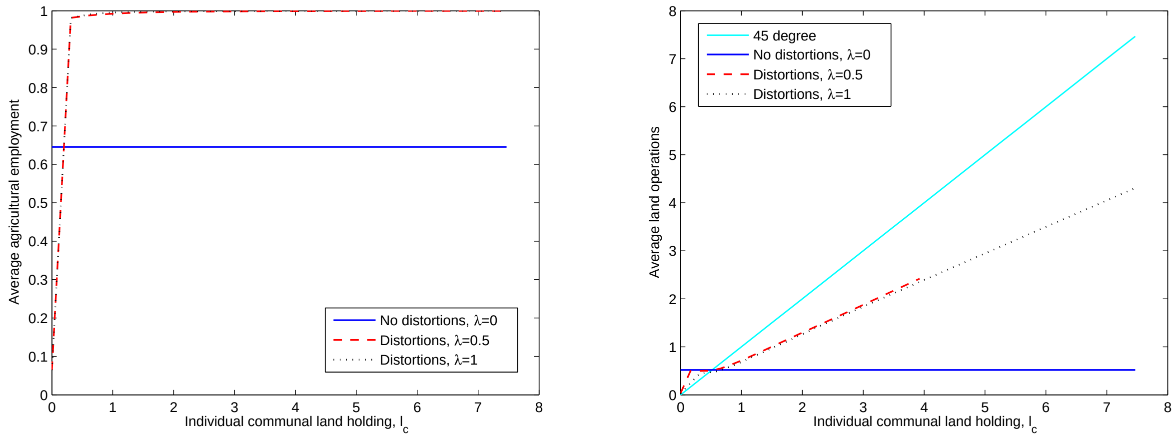
For completeness, Figure (9) relates occupations and operations to communal land holdings. The pattern is almost identical to that of the benchmark rich economy, so it does not warrant further clarification.

Finally, consider again the instantaneous impact of an unannounced policy change that terminates both the threat of expropriation as well as land transfers, Table (2). Before taking into account the resulting price changes, the farmers' direct policy response is as follows. For $\lambda = 1$ ($\lambda = 0.5$), 27.0% (62.3%) of the farmers are unconstrained in their choices. Some 11.3% (3.7%) would remain in agriculture but cut back land operations, 35.2% (30.1%) would leave farming despite not facing operational constraints, and 27.1% (3.9%) would leave farming as they also face operational constraints. In other words, the model's prediction is that in an economy such as Ethiopia - at current prices - more than 62% of the agricultural workers feel held back from non-agricultural activities because of the land tenure regime. And even in an economy with half of land being communal about one third of the farmers would prefer to leave if it were not for the policy regime. Once the price changes are factored in, the movements are much less dramatic. The model predicts that 8.9% (5.7%) of farmers would decamp from agriculture in the new



(A) Average land operations (B) Cumulative land operations

FIGURE 8



(A) Average agr. employment (B) Average land operations

FIGURE 9

equilibrium, while 12.1% (8.4%) of non-farmers would move in the opposite direction. One of the reasons often quoted for the continuation of existing communal land regimes is the fear that lifting such policies would create a huge, potentially unmanageable, flood of rural-urban migration. The models suggests that there is indeed massive pent-up demand for switching sectors, but only at *existing prices*. The attendant price adjustments are large with consequentially relatively little migration, which - depending on the reader's perspective - may be good or bad news.

5.2.2. *Aggregate statistics*

The central result of this paper is the impact of communal land on aggregate variables in a poor economy. From Figure (10) we note that contrary to the previous economy, more communal land does not lead to a substantial rise in agricultural production - we are close to subsistence requirements where consumption is highly price-inelastic. Non-agricultural production, on the other hand, declines more steeply. The combination of the two induce a decline in GDP. For three-quarters of communal land the loss amounts to a bit less than

2% - small, but not entirely negligible. The mass of additional agricultural employment at that point equals roughly 1.5 percentage points (last panel).

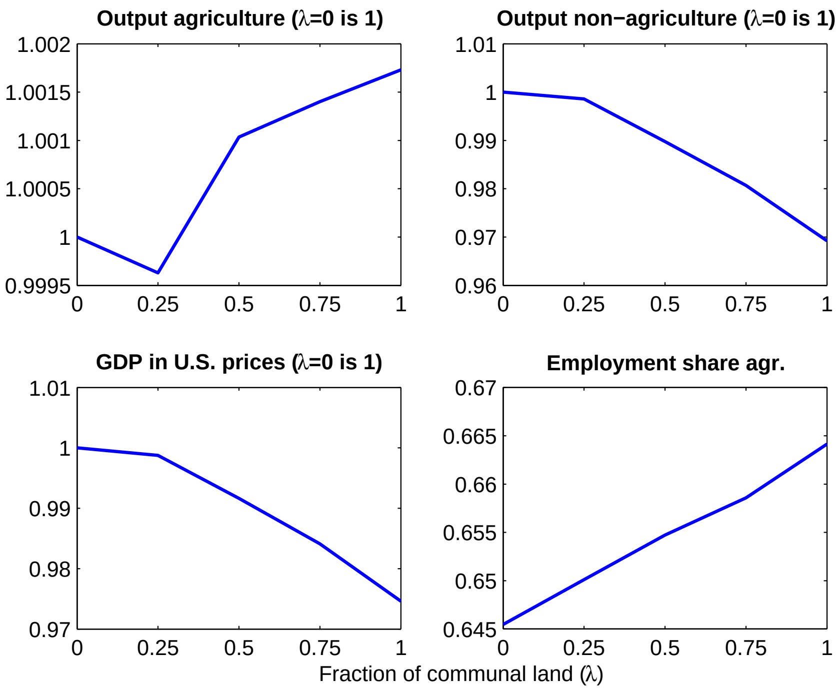


FIGURE 10. Real variables

Figure (11) reports relative productivities and prices. For $\lambda = 0.75$ real agricultural productivity relative to non-agriculture drops by no more than 4%. The reason for such a modest decline relates to the fact that the mass of switchers is not large compared to the stock of workers in either sector. It is once again nominal relative agricultural productivity that experiences a large decline, by more than 25% for the case of three-quarters of communal land. Its decomposition reveals that the lion's share of this is due to the fall in the agricultural price, amounting to more than 20%. Finally, it is worth noting that the land rental rate experiences a steady and substantial decline over the whole range of λ, in large part due to the decline of the price of food that limits demand for land. In summary, and just as in the rich economy, communal land here appears to create few distortions on the land market. What it does is to attract individuals into farming. The general equilibrium then produces a sufficiently strong drop in p to stem the wave of additional arrivals.

For completeness, Figure (12) illustrates the outcomes for additional variables of interest. What deserves attention is that the expropriation rate declines steadily over the range of λ up to the calibrated value of 0.6%. The multitude of forces at play mask a clear interpretation of that phenomenon. One reason is surely the fact that expropriation mainly hits rural-urban migrants, and there are increasingly few such individuals as λ rises. The share of farmers with no communal land also decreases as more communal land becomes available in the aggregate. The land market, meanwhile, remains quite active as observed from the last panel.

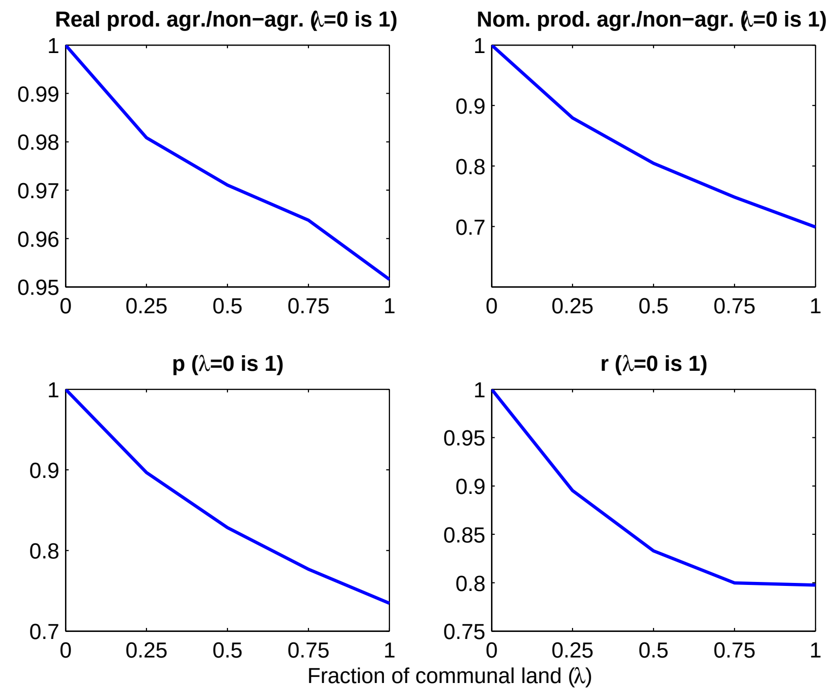


FIGURE 11. Relative productivity and prices

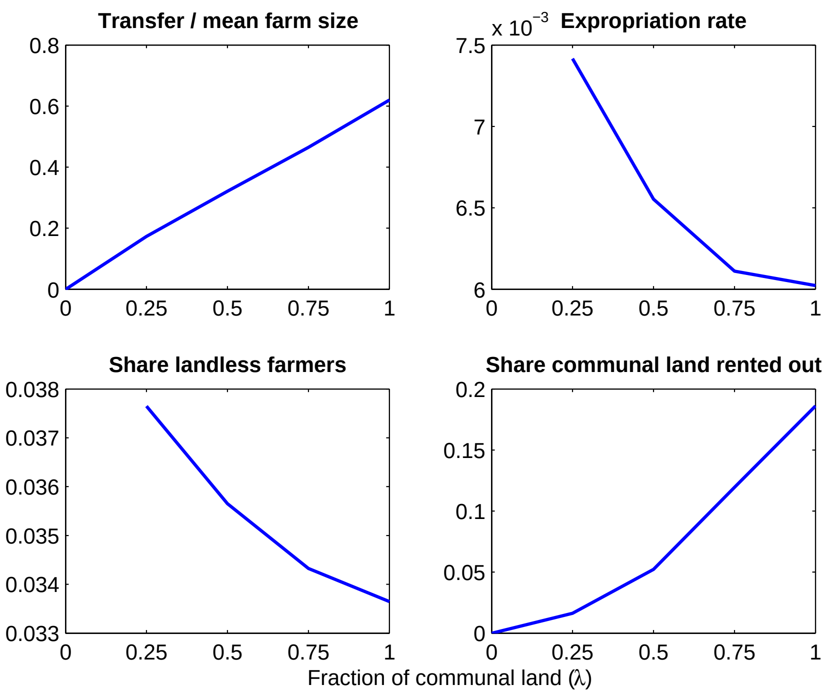


FIGURE 12. Variables on communal land

5.3. *Sensitivity*

The following section examines the extent to which the aggregate outcomes are sensitive to the chosen policy parameters. We only present the results pertaining to the poor economy as the qualitative variations are similar for the rich economy. The exercise is useful both as a robustness check and as an exploration of policies that differ markedly from the baseline parameters along any one particular dimension. The discussion, summarized in Table (3), focuses on the differential impact created by the alternative parametrization (for any $\lambda > 0$) relative to the baseline.

5.3.1. *Maximum expropriation hazard τ*

First, compare the benchmark outcomes ($\tau = 0.5$) to those resulting from either a low (0.1) or the highest possible (1) expropriation hazard. Agricultural output, just as in all the subsequent scenarios, remains flat. Non-agricultural output and thus GDP, meanwhile, falls more steeply as τ increases. A higher τ entices more individuals into farming. It also has an adverse impact on relative agricultural productivity, both real and nominal. It is noteworthy that the magnitudes stemming from $\tau = 1$ are not substantially different from $\tau = 0.5$, while the impact associated with $\tau = 0.1$ is visibly smaller albeit not entirely trivial. Interestingly, the equilibrium expropriation rate is *higher* in a world governed by a low τ, and it is increasing in the amount of communal land, λ. This relates to the fact that at low levels of τ a significant fraction of communal land is rented out, though it is surprising that the direct impact (lower expropriation hazard) is weaker than the indirect equilibrium price and sorting effects.

5.3.2. *Maximum transfer hazard ϕ*

Next we consider changes in ϕ, i.e. the ceiling probability of obtaining communal land. The variations from the benchmark (0.211) are a low value of 0.05 and the highest possible value of 1, respectively. We note that in terms of output loss, an increase in ϕ mimics the increase in τ. There is potentially more strategic occupational sorting in an equilibrium with more frequent land transfers. At the same time, however, operational misallocation is more subdued as farmers may be less reluctant to risk expropriation in view of a higher likelihood to benefit from the resulting transfers. This is why real and nominal relative agricultural productivities are less pronounced as ϕ rises (which is different from an increase in τ). Another difference is that a higher value of ϕ induces a more unequal distribution of communal land holdings, reflected in the ratio of the transfer size to the mean farm size. In general, though, the equilibrium is not very sensitive to ϕ.

5.3.3. *Convexity of expropriation hazard μ*

The benchmark value of μ is very high at 5.341. Now we consider changes towards a medium value such as 3 and subsequently to the lowest possible value of 1. By and large, the variation towards the medium value does not significantly alter the outcomes relative to the benchmark. A further decrease towards 1, however, does affect the results substantially, especially when most of the land is communal. Remember, such a change is associated *ceteris paribus* with a higher expropriation hazard and more specifically a higher expropriation hazard for current farmers. The additional frictions in the land rental market translate into distorted land operations, mirrored in the large jump in the rental rate r as well as the lower fraction of rented-out communal land. Mind that the decline in the agricultural price p is now more attenuated while the mass of farmers grows substantially larger. Intuitively, the greater misallocation of land operations requires a greater number of individuals in the agricultural sector for an equal amount of food production. As a consequence, real relative agricultural productivity takes a stronger hit than in the baseline while the nominal one remains comparable. Also, non-agricultural output and hence GDP experience larger declines. The lesson from these calculations is that our policy environment creates more pronounced *real* consequences in terms of output and employment only in the presence of both occupational and operational frictions. In addition, these larger magnitudes only materialize in a world where a large fraction of

Table 3. Sensitivity

	Bench.	Low τ 0.1	High τ 1.0	Low ϕ 0.05	High ϕ 1	Med. μ 3	Low μ 1	Med. ϵ 1	High ϵ 3	Med. μ 3 Med. ϵ 1	Low μ 1 High ϵ 3
Output agriculture (Y_a)											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Output non-agriculture (Y_n)											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99
λ= 0.50	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98
λ= 0.75	0.98	0.99	0.98	0.98	0.97	0.98	0.96	0.97	0.97	0.96	0.96
λ= 1.00	0.97	0.98	0.96	0.97	0.96	0.96	0.90	0.95	0.95	0.93	0.85
GDP											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99
λ= 0.50	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
λ= 0.75	0.98	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.96
λ= 1.00	0.97	0.98	0.97	0.98	0.96	0.96	0.91	0.96	0.96	0.94	0.87
Agricultural employment (N_a, %)											
λ= 0.00	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5	64.5
λ= 0.25	65.0	64.9	65.1	65.2	65.0	65.0	65.1	65.0	65.1	65.0	65.1
λ= 0.50	65.5	65.3	65.5	65.4	65.3	65.6	65.6	65.2	65.3	65.3	65.3
λ= 0.75	65.9	65.5	66.0	65.9	65.7	66.2	66.7	65.6	65.4	65.8	66.1
λ= 1.00	66.4	65.7	66.7	66.4	66.2	67.3	70.5	66.1	65.8	67.3	70.0
Real relative productivity $(Y_a/N_a)/(Y_n/N_n)$											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	0.98	0.99	0.98	0.98	0.98	0.98	0.98	0.99	0.98	0.99	0.98
λ= 0.50	0.97	0.98	0.97	0.97	0.98	0.97	0.97	0.99	0.99	0.99	0.99
λ= 0.75	0.96	0.97	0.96	0.96	0.98	0.95	0.94	0.99	0.99	0.98	0.98
λ= 1.00	0.95	0.97	0.95	0.95	0.97	0.92	0.85	0.99	1.00	0.96	0.92
Nominal relative productivity $p(Y_a/N_a)/(Y_n/N_n)$											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	0.88	0.91	0.88	0.88	0.89	0.88	0.88	0.89	0.89	0.89	0.89
λ= 0.50	0.80	0.84	0.80	0.80	0.82	0.81	0.81	0.83	0.83	0.84	0.83
λ= 0.75	0.75	0.80	0.75	0.74	0.78	0.75	0.76	0.80	0.79	0.81	0.81
λ= 1.00	0.70	0.76	0.69	0.69	0.74	0.69	0.71	0.77	0.77	0.79	0.89
Agricultural price (p_a)											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	0.90	0.92	0.90	0.90	0.90	0.90	0.90	0.91	0.90	0.91	0.90
λ= 0.50	0.83	0.87	0.83	0.82	0.84	0.83	0.84	0.84	0.84	0.85	0.85
λ= 0.75	0.78	0.82	0.77	0.77	0.80	0.78	0.81	0.81	0.80	0.82	0.83
λ= 1.00	0.73	0.79	0.73	0.72	0.76	0.75	0.84	0.78	0.78	0.82	0.97
Rental rate (r)											
λ= 0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
λ= 0.25	0.90	0.92	0.90	0.90	0.90	0.90	0.90	0.91	0.90	0.91	0.90
λ= 0.50	0.83	0.87	0.83	0.83	0.84	0.84	0.86	0.85	0.84	0.86	0.86
λ= 0.75	0.80	0.83	0.80	0.79	0.83	0.84	0.92	0.84	0.82	0.91	0.94
λ= 1.00	0.80	0.81	0.81	0.77	0.84	0.90	2.09	0.88	0.85	1.11	3.69
Transfer/mean farm size											
λ= 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
λ= 0.25	0.17	0.16	0.17	0.25	0.10	0.17	0.17	0.04	0.02	0.04	0.02
λ= 0.50	0.32	0.31	0.32	0.47	0.18	0.32	0.32	0.07	0.04	0.07	0.04
λ= 0.75	0.46	0.44	0.46	0.69	0.25	0.47	0.44	0.09	0.06	0.09	0.06
λ= 1.00	0.62	0.59	0.62	0.92	0.33	0.66	0.54	0.12	0.08	0.12	0.06
Expropriation rate (%)											
λ= 0.00	-	-	-	-	-	-	-	-	-	-	-
λ= 0.25	0.74	0.98	0.75	0.74	1.21	0.74	0.74	0.66	0.66	0.66	0.66
λ= 0.50	0.66	1.12	0.66	0.65	1.35	0.66	0.64	0.54	0.54	0.54	0.54
λ= 0.75	0.61	1.24	0.61	0.60	1.54	0.62	0.55	0.47	0.47	0.47	0.43
λ= 1.00	0.60	1.37	0.60	0.58	1.83	0.65	0.46	0.43	0.43	0.45	0.27
Landless farmers (%)											
λ= 0.00	-	-	-	-	-	-	-	-	-	-	-
λ= 0.25	3.76	5.93	3.78	13.47	2.12	3.76	3.75	3.53	3.51	3.53	3.51
λ= 0.50	3.57	7.40	3.58	12.50	2.92	3.55	3.54	3.23	3.15	3.23	3.16
λ= 0.75	3.43	8.71	3.40	11.70	3.76	3.41	3.28	2.98	2.89	2.92	2.75
λ= 1.00	3.36	9.94	3.32	11.17	4.72	3.42	2.79	2.73	2.68	2.67	1.72
Communal land rented-out (%)											
λ= 0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
λ= 0.25	1.63	9.90	0.90	1.54	2.62	1.54	1.48	1.45	1.32	1.37	1.32
λ= 0.50	5.22	14.34	4.41	4.29	7.54	2.90	1.28	6.30	4.35	3.17	1.08
λ= 0.75	11.95	21.81	10.68	9.05	15.15	6.20	1.11	14.02	12.96	6.77	0.86
λ= 1.00	18.61	29.94	16.78	17.13	22.88	10.48	0.91	21.46	21.09	11.83	0.54

Note: Unless otherwise indicated, variables are relative to the benchmark scenario at $\lambda = 0$.

land is communal - in the presence of some private land the operational frictions have considerably less bite because the land market is sufficiently active.

5.3.4. *Progressivity of transfer hazard ϵ*

As for ϵ, the baseline calibrated value (0.024) is low, i.e. it is very unlikely to receive an additional land transfer conditional on detaining communal land. Next, we try out a medium value of 1, followed by a high value of 3. Agricultural employment rises, and non-agricultural output falls. In magnitude, that impact is not large and occurs primarily in the first step when moving from the low to the medium value. Interestingly, a rise in ϵ substantially lowers the decline in real relative agricultural productivity relative to the baseline. The fall in nominal relative agricultural productivity is also much less acute, which is part due to a weaker decrease in p. This is because of a better alignment between communal land holdings and agricultural talent. Since skilled agricultural workers rent in, they do not risk expropriation, and are hence more likely to end up with larger holdings of communal land when they remain in farming. Not surprisingly, a rise in ϵ has similar qualitative effects to an increase in ϕ since both push up the probability of transfers. Where they differ is in their impact on the equilibrium expropriation rate as well as on the fraction of landless farmers. A higher ϵ leads to fewer landless farmers and a lower expropriation rate because of the said improved alignment of agricultural skills and land holdings.

5.3.5. *Convexity of expropriation hazard μ, and progressivity of transfer hazard ϵ*

At last we investigate the joint change of μ and ϵ, as in the baseline both are situated on extreme ends of their respective support. We first raise them to medium values 3 and 1, respectively, and then to the other extreme of 1 and 3, respectively. In other words, we raise the incidence of the tax and transfer hazard, while increasing frictions for renting-out farmers as well as the dispersion of communal land holdings. This combination leads to a higher fraction of agricultural employment and larger losses in non-agricultural output and GDP. In aggregate welfare terms it is the most harmful scenario considered here while the agricultural price p is only slightly lower than in the frictionless environment. This corroborates once again that intersectoral terms of trade are an important safety valve containing real output losses. It also hints at the, somewhat counterintuitive, conclusion that communal land regimes may be most harmful precisely in those environments where p and therefore relative nominal agricultural productivity do *not* appear abnormally low.

6. Conclusion

Are communal land regimes a major impediment to development? Our computations can certainly justify why they are perceived as a binding constraint in the eyes of a large share of farmers, and by extension in the minds of researchers and policymakers, both towards excessive operations and especially towards excessive agricultural employment. Arguably, such opinions do not internalize the price adjustments engendered by a lift of the expropriation threat. Once these are taken into account the underlying real distortions on output do not appear to be of first-order importance. One can argue that yet more restrictive policies on operations create somewhat larger losses, but the current framework of analysis will not allow for substantially bigger real effects under reasonable parametrizations. On the positive side, those with a liking for solving puzzles such as that pertaining to nominal relative agricultural productivity (including these authors) will feel partially vindicated that communal policies regimes may account for some non-trivial fraction of the cross-country gap.

Having said that, we want to emphasize that ours is a very specific class of models. Many important productive aspects of tenure security - land investments, land fragmentation, collateral, to name but a few - have not been addressed. Moreover, we ignore individual welfare implications where the interaction with financial market incompleteness plays a critical role. While communal land policies may restrict transferability, they typically serve many ulterior motives such as insurance and a commitment to time-consistent behavior, providing a safety net in an otherwise harsh environments. It is therefore not surprising that they have received much attention in the empirical development economics literature. Our exercise only underscores that many of these issues deserve to be scrutinized through the lens of an equilibrium model.

7. Appendix

7.1. *Agricultural productivity differences and tenure insecurity*

In the following subsection we document our measurement of agricultural and non-agricultural productivity. We also deliver suggestive evidence for a cross-country statistical relationship between the relative agricultural productivity and a particular measure of tenure insecurity.

7.1.1. *Construction of agricultural productivity differences*

To construct the nominal relative agricultural productivity difference (APD) we simply use 2005 World Bank data on the ratio of the agricultural value-added share, $p_aY_a/(p_aY_a + p_nY_n)$, to the non-agricultural share, $p_nY_n/(p_aY_a + p_nY_n)$, measured in current USD, and adjusted by levels of employment N in each sector. The nominal agricultural productivity gap (APG) of country i is $APG^i_{nom} = \frac{(p^i_aY^i_a)/N^i_a}{(p^i_nY^i_n)/N^i_n}$. The nominal APD is then defined relative to the U.S., i.e. $APD^i_{nom} = APG^i_{nom}/APG^{US}_{nom}$.

Table 4. Real and nominal agriculural productivity differences (US=1), ranked by GDP per capita.

Decile	N	Real APD	N	Nominal APD
1	11	.058	14	.255
2	12	.113	14	.472
3	11	.107	14	.472
4	12	.127	14	.516
5	11	.176	14	.571
6	12	.404	14	.861
7	11	.242	14	.558
8	12	.387	14	.713
9	11	.499	14	.738
10	12	.709	15	.858
Total	115	.285	141	.601

The computation of the real APD again involves the use of 2005 World Bank data as well as FAO data for the years 2004-2005. First, we start from the identity

$$p^{WB}_aY^i_a + p^{WB}_nY^i_n = p^{WB}Y^i. \tag{3}$$

This decomposes country i's real GDP measured in World Bank international dollars $p^{WB}Y^i$ into real sectoral component of value-added evaluated at each sector's respective international price. Since neither $p^{WB}_aY^i_a$ nor $p^{WB}_nY^i_n$ are available we proceed with FAO data and make two critical assumptions. The FAO collects industry-level price for agriculture to measure gross output (O) in international FAO dollars, $p^{FAO,O}_aO^i_a$. These are hence cross-country data on real agricultural output, but not real valued-added, since for years other than 1985 the FAO does not collect prices for (non-agricultural) intermediate inputs used in agriculture. In order to obtain real value-added in agriculture we make the assumption that $p^{FAO,O}_a/p^{i,O}_a = p^{FAO}_a/p^i_a$, i.e. the ratio between international and local industry prices equals the ratio between international and local value-added deflators. This gives $p^{FAO}_aY^i_a = \frac{p^{FAO,O}_aO^i_a}{p^{i,O}_aO^i_a}p^i_aY^i_a$. World Bank data on agricultural value-added in current USD, $p^i_aY^i_a$, coupled with FAO data on gross agricultural output in international and current U.S. dollars, respectively, $p^{FAO,O}_aO^i_a$ and $p^{i,O}_aO^i_a$, give us a real measure of value-added in agriculture, $p^{FAO}_aY^i_a$. The second assumption is to translate those into World Bank international prices by a factor of proportionality so that $p^{WB}_aY^{US}_a = \alpha p^{FAO}_aY^i_a$. We use the same trick as Caselli (2005) by noting that given the size of the U.S. in the construction of international prices one can assume $p^{WB}_aY^{US}_a = p^{US}_aY^{US}_a$. From that we have that $\alpha = \frac{p^{US,O}_aO^{US}_a}{p^{FAO,O}_aO^{US}_a}$. With $p^{WB}_aY^i_a$ in hand we can hence compute $p^{WB}_nY^i_n$ from (3) so that the real relative agricultural gap is $APG^i_{real} = \frac{(p_a^{WB} Y_a^i)/N_a^i}{(p_n^{WB} Y_n^i)/N_n^i}$. Finally, the real APD is defined relative to the U.S., i.e. $APD^i_{real} = APG^i_{real}/APG^{US}_{real}$.

Table 5. Agricultural productivity differences and tenure security

	(1) Nom. APD	(2) Real APD	(3) Nom. APD	(4) Real APD
GDP per capita	0.319***	0.628***		
	(6.87)	(10.75)		
Land tenure insecurity			-0.236***	-0.530***
			(-3.58)	(-6.24)
Constant	-3.544***	-7.316***	-0.416**	-0.904***
	(-8.72)	(-14.11)	(-3.07)	(-5.29)
Observations	141	115	123	105

t statistics in parentheses

Source: CEPII database, WorldBank and FAO (2005). GDP and APD's are in logs.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For each concept of APD Table (4) ranks the underlying countries in deciles according to GDP per capita and reports the average APD for each group. Clearly, the APD is increasing in GDP per capita, and comparing the first and last deciles gives factor differences of $0.709/0.058 = 12.2$ and $0.858/0.255 = 3.4$ for the real and nominal measures, respectively.[32]

7.1.2. *Agricultural productivity and tenure insecurity*

The Institutional Profiles Database (IPD), maintained by CEPII, provides an index on land tenure insecurity that covers a large number of countries. The indicator ranges between 0 and 4 and is increasing in tenure insecurity. It is constructed on the basis of answers to four aspects of tenure security, namely (1) the importance of land expropriation practices, (2) the importance of land issues in local politics/media, (3) the share of urban population with tenure rights that are not formally recognized, and (4) the share of rural population with tenure rights that are not formally recognized. In Table (5) we regress our measures of nominal and real APD separately on either the IPD indicator or GDP per worker (as well as a constant). The results suggest a statistically significant relationship whereby high levels of tenure insecurity are systematically negatively related to both the real and nominal measures of APD.

7.2. *Data sources*

7.2.1. *LSMS-ISA dataset*

The moments from the land holding distribution are computed using the LSMS-ISA dataset. This dataset reports the agricultural activity on 32,086 parcels that are operated by the sampled households (N=3,118). For most parcels (27,168), GPS coordinates are available. For 4,585 parcels no GPS coordinates are available so we use self-reported measures. For another 333 parcels, neither GPS nor self-reported measures are available. For those parcels, we impute the size of those parcels by using the median parcel size of the distribution of the other 31,753 parcels. Based on the obtained distribution of parcel

[32]The relationship here is not monotonic due to a couple of outliers, most notably Uruguay.

size, we compute the total size of land operated by household. The moments of that distribution are reported in Table (6).

Table 6. Distribution of land by household in hectares.

	Land operated	Land rented
N	3,118	836
Mean	1.78	1.09
P50	1.02	0.55
Min	0	0
Max	87.37	57.84
P25	0.42	0.15
P50	1.02	0.55
P75	1.97	1.40
Sum	1.89e+07	3.36e+06

Source: LSMS-ISA Data Ethiopia (2011).

Our next object of interest is the distribution of land rental operations. In particular, we are interested in the total size of land that is rented-in for each household. We use information from the Parcel Roster of the LSMS-ISA dataset on the acquisition of the operated parcels. Parcels can either be acquired from local leaders, inherited, rented, borrowed for free, moved-in without permission, or other. Using the above distribution of parcel sizes we compute the size of land that households either rented or borrowed for free. The distribution can be found in the second column of Table (6). The ratio of the sum of land rented over the sum of operated land is 17.7%. The second moment targeted in the calibration is the fraction of landless households. Our measure of landless households that operate in the agricultural sector is the fraction of households whose agricultural operations only occur on rented-in land, 3.4%.

7.2.2. *Own dataset*

In December 2014, we interviewed randomly selected households in seven villages (*kebele*) across four sub-regions (*woreda*) in Ethiopia's two main regions (Amhara and Oromia). In combination, the chosen locations in South Wollo and Arsi are as close to representativeness of Ethiopian agriculture as one can get in a very small sample. In each village, we interviewed six to seven households to obtain a sample of 44 households. We repeated that exercise in January 2015 in Uganda where we interviewed in five villages (*LC1*) across three districts (*LC4*). These are Luwero (*Centre*), Apac (*North*), and Jinja (*East*) that are all distinct in terms of historical evolution, climatic conditions, and land tenure arrangements. In Uganda, the total sample of households is 31. In both countries we complemented the formal interviews with a large number of semi-structured focus group discussions and key informant interviews (local leaders, extension workers, academics).

A section of the questionnaire is devoted to land expropriation and redistribution. The following Tables deliver descriptive statistics from our dataset that we use to discuss the calibration of some policy parameters. As part of our section on land expropriation and redistribution, household heads were asked whether one of their household members has been subject to land expropriation since household formation - see Table (7). Responses suggest that 6.8% have experienced expropriation in Ethiopia. We consider this number to be rather low in light of the numerous episodes of land expropriation and redistribution that have taken place in Ethiopia over the last four decades. This is confirmed by further evidence from our dataset, which documents that 36% of the parents of the household head (or spouse) experienced expropriation.

Given our model's annual frequency we adjust those expropriation rates to annual rates. To do so, we divide the computed expropriation rate by the average number of years since

Table 7. Expropriation - Descriptive Statistics

	Ethiopia		Uganda	
	Mean	Sample Size	Mean	Sample Size
Expropriation	0.068	44	0.065	31
Expropriation parents	0.36	44	0	31
Age household head	48.5	44	45.2	31
Age children	21.8	28	21.3	17

Source: Own dataset.

household formation.[33] This gives us a lower bound of 0.25%. Doing the same adjustment with the expropriation rate on the parents of the household head, and adjusting it by the average generational length of 43 years (totalling to a life expectancy of 63 years in Ethiopia) gives us an upper bound of 0.85% for the expropriation rate. Based on these rough computations, we fix the expropriation rate to 0.6%.

We also asked household heads to evaluate the tenure security of their land holdings. We document the frequency of response in Tables (8), (9), and (10).

Table 8. "Which of the following statement is true?"

	Ethiopia		Uganda	
	N	%	N	%
All of my land is completely secure from expropriation	30	68.2	22	71
Some fields are completely secure from expropriation, and some are not	6	13.6	3	9.7
There is always some risk of expropriation	5	11.4	4	12.9
My land is not secure from expropriation at all	3	6.2	2	6.4
Sample size	44	100	31	100

Source: Own dataset.

Table 9. "Do farmers in this village take any of the following actions to protect their land from expropriation ?"

	Ethiopia		Uganda	
	N	%	N	%
They prefer not to rent out land	2	4.5	1	3.2
They prefer not to reveal their intention to sell	-	-	1	3.2
They prefer not to move away	2	4.5	17	54.8
They use modern agricultural techniques	15	34.1	0	0
They plant trees	10	22.7	11	35.5
They build irrigation canals	5	11.4	0	0
They prefer not to leave land fallow	10	22.7	0	0
Other	0	0	1	3.2
Sample size	44	100	31	100

Source: Own dataset.

[33]Here, the household head's average age is 48.5 years and the average age of their oldest children is 21.8 years. If we consider a household to be created at birth of the first child, the household heads in our sample have been in that position for 26.7 years on average

TABLE 10. "Which of the following is the most important reason that local authorities grant land to a farmer?"

	Ethiopia		Uganda	
	N	%	N	%
Output, if farmer produces little	1	2.3	1	4.2
Output, if farmer produces much	4	9.1	7	29.2
Skills, if farmer is skilful	5	11.4	4	16.7
Skills, if farmer is not skilful	0	0	0	0
Land ownership, if farmer has little land	18	40.9	1	4.2
Land ownership, if farmer has much land.	0	0	0	0
Land quality, if farmer has bad quality land	0	0	1	4.2
Land quality, if farmer has good quality land	0	0	0	0
Household size, if farmer has large household	0	0	1	4.2
Household size, if farmer has small household	0	0	0	0
Age, if farmer is old	0	0	0	0
Age, if farmer is young	3	6.8	3	12.5
The household is respected in the community	1	2.3	1	4.2
It is completely random, nothing changes the odds	12	27.3	5	20.8
Sample size	44	100	24	100

Source: Own dataset.

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